LANDS DIRECTORATE

DIRECTION GENERALE DES TERRES

LAND USE CLASSIFICATION SYSTEMS: AN OVERVIEW

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LAND USE CLASSIFICATION SYSTEMS:
AN OVERVIEW

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ABSTRACT

The Land Use Monitoring Division of Lands Directorate is in the process of developing a land use classification system for the purpose of measuring land use change in Canada. A preliminary step in this process has been the review of existing systems. Over the last two decades a prolification of land use classification systems have been devised in an attempt to organize the earth's surface according to activity, cover, and structural classes in a variety of urban to wildland situations.

This Working Paper presents, in one volume, an overview and brief description of a large number of these systems which have been developed in Canada, the United States, and elsewhere. The systems range from those successfully tested and widely applied, to those which relate to a specific situation or are theoretical.

It is hoped that through the publication of this text researchers will be able to examine in a comprehensive and convenient format existing land use classifications. This should help prevent duplication of effort and could preclude unnecessary development of additional classification systems.

RÉSUMÉ

La division de la surveillance de l'utilisation des terres, de la Direction générale des terres, est en train de mettre au point un système de classification de la vocation des terres qui permettra d'étudier l'évolution de l'utilisation des terres au Canada. Il a fallu procéder, dans une étape préliminaire, à faire la révision des systèmes déjà en place. Dans les deux dernières décennies, on a constaté une prolifération de systèmes de classification de l'utilisation des terres. Ces systèmes voulaient cataloguer la surface de notre planète, en fonction des classes relatives à sa vocation, à sa couverture, ou à sa structure, et cela indépendamment des contextes urbains ou naturels, fort divers d'ailleurs.

Ce document de travail nous donne, dans un même ouvrage, un aperçu et une description sommaire, d'un grand nombre de systèmes de classification élaborés au Canada, aux Etats-Unis et ailleurs dans le monde. Ces systèmes possèdent un éventail très large; certains ont été parfaitement vérifiés et font l'objet d'une application fréquente, tandis que d'autres se limitent à des situations spécifiques et conservent ainsi un caractère peu pratique.

Nous espérons que cet ouvrage deviendra pour les personnes qui s'adonnent à la recherche, un instrument pratique qui les aidera à mieux comprendre la classification de l'utilisation des terres que nous connaissons déjà. Nous croyons que les efforts ne seront plus exercés vainement et que les systèmes de classification additionnels cesseront de proliférer inutilement.

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INTRODUCTION

"Inquiry into every distinct field of study must begin with classification, that is, the sorting of a set of phenomena composed of generically-alike units into classes or kinds, each class or kind consisting of members having definable characteristics in common.

"First, without classification, these phenomena would remain merely a bewildering multiplicity; the precise and unambiguous communication of ideas and concepts concerning these phenomena would be impossible. Second, classification of the phenomena involved is essential if generalizations are to be made concerning these phenomena. For we are generally interested in general truths--that is, truths related to classes or kinds rather than to their individual members; a truth discovered about such a member is always implicitly applied to the entire group to which the member in question belongs. Without classification such generalizations would also be impossible. And, finally, the evolution of a body of reliable knowledge concerning any set of phenomena through the process of accretion would be extremely difficult without classification. For in its absence every investigator embarking upon a course of enquiry would be compelled to retrace the same paths which had been traveled upon by countless others before him. The accumulation of knowledge under this condition might take place but only at an agonizingly slow pace." (Shapiro, 1959).

The Need for Land Use Classification

In response to Shapiro's dictum that inquiry into every field of study must begin with classification, as the demands of western society upon finite terrestrial resources have accelerated, so too has interest in the methodology and application of land use classification. The origins of land use classification go back several decades, as will be shown, but the need to determine more effective classification systems for a broad range of policy, planning, and management situations is widely recognized. Anderson et al. observed of the American scene, for example:

"One of the prime prerequisites for better use of land is information on existing land use patterns and changes in land use through time. The U.S. Department of Agriculture (1972) reported that during the decade of the 1960's, 730,000 acres (296,000 hectares) were urbanized each year, transportation land uses expanded by 130,000 acres (53,000 hectares) per year, and recreational area increased by about 1 million acres (409,000 hectares) per year. Knowledge of the present distribution and area of such agricultural, recreational, and urban lands, as well as information on their changing proportions, is needed by legislators, planners and State and local government officials to determine better land use policy, to project transportation and utility demand, to identify future development pressure points and areas, and to implement effective plans for regional development...

"The variety of land use and land cover data needs is exceedingly broad. Current land use and land cover data are needed for equalization of tax assessments in many States. Land use and land cover data also are needed by Federal, State, and local agencies for water-resource inventory, flood control, water-supply planning, and waste-water treatment. Many Federal agencies need current comprehensive inventories of existing activities on public lands combined with the existing and changing uses of

> adjacent private lands to improve the management of public lands. Federal agencies also need land use data to assess the environmental impact resulting from the development of energy resources and minimize man-wildlife ecosystem conflicts, to make national summaries of land use patterns and changes for national policy formulation, and to prepare environmental impact statements and assess future impacts on environmental quality." (Anderson et al., 1976).

Much of the need for satisfactory land use classification procedures has been expressed in the urban and urban-fringe landscapes. Indeed these landscapes are the focus of the majority of classification schemes extant today. While the need for land use classification in the urban landscape is generally well established (Clawson and Stewart, 1965), attention to the urban fringe is a more recent phenomenon. Russwurm noted the following on the Canadian situation:

> "The land surrounding our cities is our most valuable body of land still largely unbuilt on. It is so valuable because it is easily accessible to present and future populations of housing, land site, recreation and resource uses. It contains much of our most productive agricultural land. It contains the source of most city water supplies. It contains sand, gravel, and stone needed for buildings and roads. It contains open space, scenic areas and outdoor recreation resources needed for spiritual and play purposes. And it contains most of the land which will be used for future economic, cultural, and housing activities of Canadians." (Russworm, 1976).

Russwurm recognized that existing land use classifications (e.g., U.S. Standard Land Use Coding Manual) may be used to describe these urban fringe activities, but that classifications dependent on land use and land cover only generally are inadequate for the purposes of policy making and planning implementation. Indeed it is this perceived shortcoming of existing classification schemes which has spawned successively modified systems. A recurring statement found in many of the background documents was that the authors or agencies had examined many land classification systems but generally none could be adopted in their entirety to the authors' or agencies' needs. This situation has given rise to the plethora of primary and secondary systems now in existence.

Basic Concepts of Land Use Classification

Discussions on the basic concepts of land use classification will be found in many of the references cited in the bibliography. Clawson recognized nine "major ideas or concepts about land":

1) "Location on the relation of a specific parcel of land to the poles, the equator, and the major ocean and land masses." There are also relationships between various tracts of land, as well as a political location;

2) "Activity on the Land; for what purpose is this piece of land or tract used?";

3) "Natural qualities of the land, including its surface and subsurface characteristics and its vegetative cover";

4) "Improvements to and on land." This is closely related to activity, although the two are quite distinct;

5) "Intensity of land use, or amount of activity per unit of area";

6) "Land tenure. Who owns the land, who uses it, etc.?";

7) "Land prices, land market activity, and credit as applied to land";

8) "Interrelations in the use between different tracts of land. No piece of land stands alone..."; and

9) "Interrelation between activities on the land and other economic and social factors." (Clawson, 1965).

Guttenberg (1965) believed that a system "must be capable of putting land use data into a form which corresponds to the practical concerns and responsibilities of planning"; and Hodge and McCabe (1968) enunciated desirable features to make land use classification and coding systems comprehensive yet flexible. The system should:

- be easy to understand;
- be suited to manual as well as electronic processing;
- allow for a healthy balance between the investment (in money and manpower) that a community is prepared to make and the results it can expect from it;
- be a useful tool to planners in local, regional, and national planning;
- be economical to maintain; and
- be capable of accommodating information stored in a wide variety of existing systems.

As both the type and volume of data increase, the need to develop standardized classification systems becomes more acute. The prospects of standardization by many levels of government and institutions have improved with the introduction of remote-sensing and data-processing techniques. Certain recent classification systems have been introduced to simultaneously take advantage of technology and to introduce standardization procedures in land use classification (e.g., Classification System C.1).

The Historical Background

The historical origins of land use classification cannot be readily ascribed to any one source. However, seminal influences may be identified along the way and doubtless other primary contributions may be anticipated in the future. Amongst the very early attempts at classification was the series of County Reports on the state of agriculture commissioned by the Board of Agriculture and Internal Improvement in Great Britain in 1793. The Board was established by the government of George III and many of the County Reports prepared for it included a map of the soils of the county "named, classified, and described by farmers for farmers... These early maps are in fact crude maps of soil regions and indicate a classification of land based on soil texture" (Stamp, 1960).

What Nicholson et al. (1961) recognized as the earliest precedent for "purely objective...land-use mapping" also had its origins in the British Isles. This was the first Land Utilization Survey of Britain which was initiated by L. Dudley Stamp in 1930. The survey which was often compared with the Domesday Survey, "had no ulterior motive, which the Domesday Survey had in the matter of taxation, and its object was simply to record the factual position" (Stamp, 1960). The classification system contained six major categories and would be later developed in the World Land Use Survey Classification (A.1) and the Second Land Use Survey of Britain (A.2).

In the United States, the need for an objective, fact-finding approach to the solution of land use problems was recognized

early in this century and was later reflected on many fronts ranging from soils classification to urban land use classification. The history of land use classification in the United States is summarized by Clawson and Stewart who, in 1965, included in their book the subsequently much-used Standard Land Use Coding Manual (U.S. Dept. Transport, 1969) (see D.1).

Many of the recent developments in the use of remote sensors as the primary means of data gathering have occurred in the United States. The origins of remote-sensor data gathering in that country may be traced back several decades to the work of the Tennessee Valley Authority (1935). The recent work of agencies such as the United States Geological Survey (see C.1) has done much to further the role of advanced technology in fulfulling land use classification needs.

Purpose of the Report

This report presents in one volume an overview and brief description of a large number of land use classification systems which have been developed in Canada, the United States, and elsewhere. Information on these classification systems has been accumulated by the Land Use Monitoring Division of Lands Directorate, Environment Canada, and these data represent the greater part of the material reviewed by the writer for this report.

Forty-six systems of land use classification are presented, most of which have been developed during the last twenty years. They include not only those which are well known, but also many which have received only limited distribution. This number embraces most of the historic and contemporary systems, but it falls far short of the total number of land use classifications known to be in use at the present time. Witness, for example, the observation by the authors of the United Kingdom's National Land Use Classification (F.5), the only contemporary British classification system included in this report, that they discovered 21 classification systems in use by local authorities in England, Scotland, and Wales. In similar vein, the United States Geological Survey's Land Use and Land Cover Classification System (C.1) is being adopted in modified form (usually at Levels 3 and 4) by individual states throughout the Union (see Group C).

Land use classification systems differ from each other in many and often distinctive ways. This variation is reflected in the systems presented in this document. Generally the systems range from those which have been successfully tested and widely disseminated and used in their original or in some modified form (notably those herein identified as "primary" systems), to those which stand uniquely alone; some the untested models of the academician, others having application to a specifically local set of conditions. For each classification system we may pose the question: is the classification a result of recognition of information needs of potential users with the classification scheme designed to meet this need; or, is it the result of identification of a methodology which will accommodate certain land use classes or categories at certain levels of interpretation?

The report carries an implied message (though not a new one), that the persistent proliferation of land use classifications seems to be getting out of hand, with potentially negative results for land use planning and management and for the process as whole. There are already those, such as Young (1972), who have impugned land use classification, and arguments that the perfection of techniques at the expense of usefulness and applicability may justified if new classifications with very prescribed temporal and spatial limits keep popping up. Thus, an appeal is expressed that, rather than abandon existing classification systems with the too-often espoused remark "no system could be found which met our needs", the reader examine what is offered here. He may not find exactly what he thinks he wants, but an extra effort expended in the search may ultimately yield savings in time and money and preclude initiation of yet another land use classification exercise.

Report Format

This introduction provides a general account of the role of land use classification, how classification procedures have developed over time, and what constitute some of the basic concepts of land use classification.

The second section is a summary of the land use classification systems, presented in tabular form. These sheets provide the reader with an "at a glance" opportunity to compare and contrast certain of the characteristics of the forty-six systems described in more detail in the following section without having to read the information on each system in its entirety.

The main body of the report is a brief description of each of the forty-six land use classification systems. For the purposes of this report the systems have been divided into two categories, primary and secondary. Primary classification systems are recognized to be those which in content and applicability possess classification techniques and procedures that are innovative in nature and/or which serve as models for other systems. The secondary systems are those which have been derived in whole or in part from the methodologies and techniques employed in a primary system or systems. In most instances, these derived systems will have application to a specific piece of territory (as distinct from the usually conceptualized methodology for unspecified pieces of territory in primary systems), ranging from a province or state to small urban centres. These secondary systems may not be readily transferable to other territories or jurisdictions in the form in which they have been developed for the original application at the secondary level.

Future Directions

It is probable that land use classification systems will continue to increase in number. Notwithstanding attempts at standardization, principally through the preparation of primary systems, many of the future systems will be unique to a specific piece of territory or to an agency's geographical area of responsibility. Such systems usually will not be amenable to replication elsewhere. It is probable, however, that standardized or primary classifications will continue to gain ground as agencies and institutions increasingly

have access to the technology required for developing secondary systems and as the costs of developing unique, localized systems become increasingly prohibitive.

LAND USE CLASSIFICATION SUMMARY

Land use classification systems differ from each other in many ways, and some examples of these distinctions have already been cited. The data in the following sheets represents in tabular form some of the critera used to determine the place of each classification system in the field as a whole:

1. the title of each classification system in this volume;
2. the relationship between the classification systems
3. whether the system is one-level or hierarchic;
4. mapping information (scale, colour, and the number of categories);
5. the manner in which data is gathered;
6. the accuracy of the classification system;
7. the users of the system; and
8. additional general information.

Other criteria were identified and used in relating the classifications to each other, but space considerations and often few facts precluded these from being incorporated in the summaries. Amongst these are:

9. agency or individual primarily responsible for the development of the system;
10. date and place of publication of information about the system;
11. present status of use (being developed, used for finite period, in use etc.);
12. computer output scale of data;
13. basis for each of land classes (activities, cover, structure etc.);
14. frequency of survey;
15. system's contribution to present land use analysis versus future land use changes; and
16. cost and resources used to gather information on the bases of the classification systems.

CLASSIFICATION SYSTEM	TITLE	RELATIONSHIP TO OTHER SYSTEMS	ONE-LEVEL OR HIERARCHIC	MAPPING INFORMATION	DATA GATHERING/ HANDLING	ACCURACY	USERS	OTHER INFORMATION
A.1	World Land Use Classification	see First Land Use Survey of Britain	one-level	9 categories at 1:1,000,000 colour coded	field survey		governments, planners, and educational institutions	
A.2	Second Land Use Survey of Britain Classification	derived from A.1	hierarchic	13 categories at 1:25,000 (Level I) 64 categories of information can be recorded colour coded	field survey using 6-inch maps		governments, planners, and educational institutions	prepared in field by volunteers and paid surveyors
A.3	Canadian Land Use Classification	derived from A.1	hierarchic	7 categories at 1:1,000,000 (Level I) 22 categories at 1:500,000 or larger colour coded	field survey		governments and planners	map making: at 1:500,000 requires 118 man-days; at 1:50,000 requires 48 man-days per map
B.1	Canada Land Inventory, Land Capability and Land Use Classification	see A.3	one-level	6 categories at 1:250,000 (Level I)	field survey and air-photo interp.		governments, planners, consultants, and educational institutions	
B.2	Canada Land Inventory, Present Land Use in Manitoba	derived from B.1	hierarchic	10 categories at 1:50,000 (Level I) Min. area to be mapped is 1/8" x 1/8" square (6.4 acres on ground)	field survey and air-photo interp.		Governments of Canada and Manitoba	
B.3	Manitoba Rural Land Use Classition	derived from B.1	one-level	10 categories at 1:50,000	field survey and air-photo interp.		Governments of Canada and Manitoba	
B.4	Pilot Land Use Planning, The Pas, Manitoba	derived from B.1	one-level	13 categories at 1:48,000	field survey and air-photo interp.		Governments of Canada and Manitoba	covered 110,000 acres
B.5	British Columbia Present Land Use Classification	derived from B.1	hierarchic	23 categories at 1:50,000 (Level I) 40 categories at 1:25,000	field survey and air-photo interp.		Governments of Canada and Manitoba	

CLASSIFICATION SYSTEM	TITLE	RELATIONSHIP TO OTHER SYSTEMS	ONE-LEVEL OR HIERARCHIC	DATA GATHERING/ MAPPING INFORMATION	HANDLING	ACCURACY	USERS	OTHER INFORMATION
B.6	Ottawa Urban Fringe Area Land Use Classification	derived from B.1	hierarchic	5 categories at 1:25,000 mapping area as small as 1/3 acre	field survey and air-photo interp.		Soil Research Institute	70,000 acres surveyed
B.7	Land Capability and Development Constraints Map Midwest Ontario Economic Region	derived from B.1	one-level	12 categories at 1:250,000			Ontario Dept. of Treasury and Economics	
B.8	Changes in Land Use on Either Side Québec-Vermont Border	derived from B.1 and Vermont Land Capability Plans	one-level	13 categories at 1:63,000 and 1:34,000	field survey and air-photo interp.		McGill University	28 types of land use changes developed and used in study
B.9	Mirabel Study (EZAIM) Land Use Classification	derived from B.1	hierarchic	5 categories at 1:20,000 (Level I)	field survey and air-photo interp.		National Research Council and EZAIM Group	
B.10	Remote Sensing Compatible Land Use Activity Classification	derived from B.1	hierarchic	7 categories at 1:250,000 (Level I) 19 categories at 1:50,000	field survey and remote sensing		for users of CLI Present Land Use Data	
B.11	PEI Land Capability and Land Use Classification for Appraisal Purposes	derived from B.1	one-level	various categories based on 1:5,000 land ownership maps	field survey		PEI Land Valuation and Assessment Div.	
C.1	Land Use and Land Cover Classification System for Use with Remote Sensor Data	origins lie in several pre-existing systems	hierarchic	9 categories at > 1:24,000 to 1:1,000,000 37 categories at < 1:80,000 unlimited number of categories at 1:20,000 to 1:80,000 (Level III) and at > 1:20,000 (Level IV)	Satellite and aircraft remote sensor at all levels, possibly supplemented by ground survey and enumeration at Levels II, III, and IV	at Levels I and II accuracy of interp. satisfactory when correct interp. is made 85% to 90% of time	federal, state, and local agencies	

CLASSIFICATION SYSTEM	TITLE	RELATIONSHIP TO OTHER SYSTEMS	ONE-LEVEL OR HIERARCHIC	DATA GATHERING/ MAPPING INFORMATION	HANDLING	ACCURACY	USERS	OTHER INFORMATION
C.2	Florida Land Use Land Cover Classification System	derived from C.1	hierarchic	7 categories at 1:1,000,000 or at 1:500,000 40 categories at 1:126,720 141 categories at 1:24,000 unlimited categories at Level IV	satellite and aircraft remote sensor at all levels, possibly supplemented by ground survey and enumeration at Levels II, III, and IV	see C.1	federal, state, and local agencies	
C.3	Michigan Land Cover/Use Classification	derived from C.1	hierarchic	7 categories at 1:250,000 to 1:1,100,000 27 categories at 1:125,000 to 1:250,000 99 categories at 1:50,000 to 1:250,000 unlimited categories at 1:24,000 to 1:50,000 (Level IV)	satellite and aircraft remote sensor at all levels; ground survey and enumeration at Levels I, III, and IV.	see C.1	federal, state, and local agencies	
C.4	Prince Edward Island Present Land Use	derived from C.1 C.3	hierarchic	mapping has occurred at 1:5,000 and 1:10,000 at least three levels of information to be displayed	existing data, field survey, and air-photo interp.	see C.1	Government of Prince Edward Island	
C.5	State of Idaho Proposed Uniform Land Use Classification System	derived from C.1	hierarchic	12 categories at 1:250,000 40 categories at 1:125,000 at Level I, 40 acres is min. grid or polygon; 10 acres at Level II	satellite and aircraft remote sensor, and field survey	see C.1 10% in accuracy at Levels I and II	Idaho State Planning and Community Affairs Agency, and Federation of Rocky Mountain States	
C.6	State of Idaho Comprehensive Land Use Planning	derived from C.1	hierarchic	8 categories at Level I 3-level system of mapping recommended	satellite and aircraft remote sensor, and field survey	see C.1	Idaho Bureau of State Planning and Community Affairs	

CLASSIFICATION SYSTEM	TITLE	RELATIONSHIP TO OTHER SYSTEMS	ONE-LEVEL OR HIERARCHIC	DATA GATHERING/ MAPPING INFORMATION	HANDLING	ACCURACY	USERS	OTHER INFORMATION
C.7	Vegetation and Land Use Map of New Mexico	derived from C.1	hierarchic	24 LANDSAT colour composite transparencies at scale of 1:1,100,000; use USGS township and range map	satellite and aircraft remote sensor	see C.1	New Mexico agencies and institutions	
C.8	Land Use in Iowa: 1976, an Explanation of the Map	derived from C.1	hierarchic	9 images produced by LANDSAT I multi-spectral scanner system; supplemented by 1:80,000 colour-infrared aircraft photos; map produced at 1:125,000	satellite and aircraft remote sensor	see C.1	Iowa agencies and institutions	
C.9	Colorado Land Use Classification	derived from C.1	hierarchic	primarily designed for compilation and mapping at 1:24,000 using USGS base maps and 1:24,000 quad-centred air-photo enlargement; three or four levels at 1:24,000; min. area of 5 suggested acres	satellite and aircraft remote sensor, and field checking	see C.1	Colorado agencies and institutions	
C.10	State of Montana Proposed Statewide Land Use Mapping Program	derived from C.1	hierarchic	11 categories at 1:125,000 min. size: 40-acre cell	satellite and aircraft remote sensor, and existing data field checking	see C.1	Montana agencies and institutions	
C.11	Urban Land Use Identification from High-Altitude Aerial Photography	relationship with C.1	hierarchic	variety of categories and scales discussed	satellite and aircraft remote sensor		urban and regional planning agencies	
D.1	United States Standard Land Use Coding Manual Classification	relationship with standard industrial classification	hierarchic	9 Level I categories 67 Level II categories 294 Level III categories 772 Level IV categories	field survey and data files		Large number of urban, metropolitan, and regional agencies	

CLASSIFICATION SYSTEM	TITLE	RELATIONSHIP TO OTHER SYSTEMS	ONE-LEVEL OR HIERARCHIC	DATA GATHERING/ MAPPING INFORMATION	HANDLING	ACCURACY	USERS	OTHER INFORMATION
D.2	Alberta, Dept. of Municipal Affairs Land Use Classification for Towns, Villages, Hamlets, and Small Cities	derived from D.1	hierarchic	9 Level I categories	field survey and data files		Small communities in Alberta	see F.6
D.3	City of Halifax Land Use Classification	derived from D.1	hierarchic	11 Level I categories 70 Level II categories 460 Level III categories	field survey and data files		City of Halifax	
D.4	Oak Ridge Land Use Classification System	derived from D.1	hierarchic	4 levels of categories with 9 Level I categories	field survey and data files		Oak Ridge	
D.5	Saskatchewan, Dept. of Municipal Affairs Land Use Classification	derived from D.1	hierarchic	9 Level I categories	field survey and data files		Saskatchewan Government agencies	
E.1	Ontario Land Use Classification	N/A	hierarchic	10 categories at Level I in structure code 8 categories at Level II in activity code				
E.2	Ontario Urban and Regional Trans. Planning Office Land Use Classification	derived from E.1					originator	
F.1	Ontario Highway Div., Surveys and Plans Office Land Use Classification	N/A	hierarchic	8 categories at Level I			originator	
F.2	Greater Vancouver Regional District Land Use Classification	N/A	hierarchic	13 categories at Level II			originator	

CLASSIFICATION SYSTEM	TITLE	RELATIONSHIP TO OTHER SYSTEMS	ONE-LEVEL OR HIERARCHIC	DATA GATHERING/ MAPPING INFORMATION	HANDLING	ACCURACY	USERS	OTHER INFORMATION
F.3	New York State Land Use and Natural Resources Inventory	N/A	hierarchic	10 Level I categories 51 Level II categories 68 Level III categories	air photography and interp. field checking		originator and other planning agencies	
F.4	Minnesota Land Use Classification	N/A	one-level	18 land use combinations			originator	
F.5	National Land Use Classification United Kingdom	N/A	hierarchic	15 categories at Level I	field survey and data files		Local government and planning authorities	
F.6	Land Related Information Systems in Alberta	N/A	hierarchic	3 hierarchic systems are discussed	various mechanisms		Alberta municipal, planning, and other agencies	
F.7	Québec Urban Agglomeration Land Use Classification	N/A	hierarchic	7 categories at Level I	field survey		Québec universities	
F.8	Nova Scotia Dept. Municipal Affairs Settlement Oriented Land Use Classification	N/A	hierarchic	10 categories at Level I	air-photo interp. and field survey		originator	
F.9	Monroe County, New York Land Use Classification	N/A	hierarchic	3 level system with 9, 60, and 141 categories at Levels I, II, & III respect.			originator	
F.10	Metro. Toronto Planning Board Land Use Classification	N/A	hierarchic	11 categories at Level I	field survey		originator	

CLASSIFICATION SYSTEM	TITLE	RELATIONSHIP TO OTHER SYSTEMS	ONE-LEVEL OR HIERARCHIC	DATA GATHERING/ MAPPING INFORMATION	HANDLING	ACCURACY	USERS	OTHER INFORMATION
F.11	Northeastern Illinois Metro. Area Planning Commission Land Use Classification	N/A	hierarchic	9 categories at Level I three levels	field survey		originator	
F.12	Detroit Metro. Area Land Use Classification	N/A	hierarchic	10 categories at Level I	field survey		originator	
F.13	Ecologically based Remote Sensing Classification System for the Kananaskis Area	N/A	hierarchic	4 levels with 9 categories at Level I	satellite and aircraft remote sensor, field check		ecosystem planners	
F.14	Ecological Grading and Classification of Land-Occupation and Land Use Mosaics	N/A	hierarchic	4 categories or "Panels" at Level I	air-photo interp. and field survey			

THE PRIMARY AND SECONDARY LAND USE CLASSIFICATION SYSTEMS

This section provides individual reviews or summaries of land use classification systems. These systems are derived primarily from North American experience, but a few have been developed elsewhere. Information for each system has been developed from the references cited in the bibliography. Usually this information is taken from one or two source documents which are identified in the text, although others relevant to the classification system may be found in the bibliography.

Where possible there are brief descriptions of the age and origins of each system; reference as to which individual or agency instituted the system and for what purpose or purposes; an account of the technical and fiscal characteristics of the system; and what resources are required to develop or utilize it. In most instances, the text for each system is accompanied by a table or tables which detail a portion or all of the types or categories and levels of classification presented in the system. [Note: Many of the tables contain lengthy extracts from reports rather than conventional tabular material but, rather than separate this material into an appendix, it is included with the classification which it describes.]

The classification systems are divided into two orders, primary and secondary. Each primary system is identified by a letter of the alphabet and the numeral 1. Each secondary system is listed after the primary system to which it most closely relates and it is given the same letter of the alphabet as that system. Tables are numbered consecutively in the system in which they appear.

Five sets of land use classification (Groups A to E inclusive) are presented. The final group (Group F) consists of miscellaneous classification systems, most of which may be considered as primary systems in their own right, but for which no set of secondary or derivative systems are at hand. There may be occasional reference, however, to other systems known to be derived from a Group F system (e.g., Black River -- St. Lawrence Regional Planning Board's adaptation of the New York State LUNR system, F.3). Some words of caution are in order before reading on.

1. The documentation at hand for the descriptions of each of the systems is extremely varied and accordingly it has not been possible in every instance to provide a comprehensive account of the system. The source materials may range from detailed descriptive manuals to pages of correspondence between staff of the Lands Directorate, Environment Canada and individuals intimately involved in the development and implementation of a classification system. Where background

information is scant this project's limitations have been such that a search for additional details generally has not been possible. All reference materials that may be reasonably retrieved are listed in the bibliography and cited in the text.

2. The information presented may not always be entirely up-to-date. There is considerable ongoing experimentation and innovation in the field of land use classification but developments may not always be widely reported. When reporting does occur, the results may appear in print at a date considerably later than the implementation of a classification program.

3. The descriptions of the classification systems draw heavily upon the texts contained in the documents appropriate to each system. The information provided by the original authors is often paraphrased or quoted directly. This arrangement provides for both accuracy of description and conserves the amount of space required to describe the system. Extensive quotation is employed in instances where the author's words defy synthesis by this writer.

LAND USE CLASSIFICATION GROUP A

A.1: WORLD LAND USE CLASSIFICATION (primary system)

The World Land Use Classification had its origins in the 7th General Assembly of the International Geographical Union which met in 1949. During the Assembly a commission was appointed to study the possibility of a world land use survey. In the following year S. Van Valkenburg described the work of the World Land Use Commission (Van Valkenburg, 1950), including a proposed World Land Use Classification, and this statement essentially was repeated in the Commission's first report to the 8th General Assembly in 1952. A more-extensive report was prepared for the 9th General Assembly in 1956. The commission expressed the need for a world land use survey in the following words (Intl. Geog. Union, 1952):

> "...we consider that present factual knowledge is inadequate to serve as a proper foundation for schemes of improvement and development ... Since all development and redevelopment must obviously start from the present position, we believe that the two immediate and prime essentials are an exact knowledge of the present position and, as far as possible, an understanding of the reasons for that position.
>
> "We therefore consider that for all parts of the world there should be a survey of land use together with an interpretation. This involves (a) maps embodying the survey and (b) explanatory memoirs.
>
> "We therefore propose a world organization under the auspices of the International Geographical Union to carry out the programme.
>
> "The first object of the survey will be to record the present use of land in all parts of the world on a uniform system of classification and notation, with such amplification as may be necessary locally. The Survey will be carried out on the most appropriate scale available to secure accuracy and will be based essentially on field work, together with the interpretation of such materials as air photographs.
>
> "The second object of the Survey is to secure the publication of results ... on the scale of 1:1,000,000 (approximately 15 miles to the inch) which it is proposed to publish. It is planned that this series of maps shall eventually cover the whole world."

The Commission selected the 1:1,000,000 scale because "it is the only scale on which maps are available for all the world and is sufficiently large to present the global picture". Also "the millionth map has the advantage of unjformity, permits comparative studies, and is on a convenient scale where large schemes of development are under consideration" (Van Valkenburg, 1950).

A world land use classification or master key was constructed by the Commission to be used for the 1:1,000,000 map. The master key is colour-based in order to secure uniformity in the land use categories. Although the classification is non-hierarchic at the 1:1,000,000 scale it is intended that it should be enlarged according to needs dictated by local conditions and the scale of maps on which the survey is being carried out. These additional details, however, should fall within the categories of the master key. For example, cropland which appears as brown on the 1:1,000,000 scale may be subdivided into hay, grain, potatoes, and so on, on a large-scale map by employing various shades of brown.

The following description is extracted from the Report of the Commission on World Land Use Survey for the period 1949-1952 (Intl. Geog. Union, 1952).

1. "Settlements and Associated Non-Agricultural Land (dark and light red)

Whilst on the 1:1,000,000 map it will not be possible to do more than indicate by one color (dark red) the areas covered by cities and towns, in industrial and developed countries where large-scale maps are available it may be desirable to distinguish between different types of settlement on the survey maps. According to need, local classifications may be used to distinguish between different phases of urban land use of functional zones.

Extensive surface mining areas including land devastated owing to mine operations should be indicated in light red and explained in accompanying notes.

2. "Horticulture (deep purple)

This category should be used to include all intensive cultivation of vegetable and small fruits (as distinguished from tree fruits). The category, therefore, covers such agriculture as truck farming in America, market gardening in Britain and other European countries, as well as the production from larger gardens and allotments, whether the crops are grown for sale or not. Where vegetables are grown in rotation with ordinary farm crops the area should be recorded as category 4, cropland. This category of horticulture also includes the 'garden cultivation' of tropical villages - for example, in Africa, Malaya, etc., where the village compound usually includes mixed vegetables such as yams, potatoes, with fruit and sometimes with small numbers of palm trees, cocoa trees, bananas, etc.

3. "Tree and Other Perennial Crops (light purple)

A very wide range is covered by this category and the land to be included will differ very much from one part of the world to another, so that in each different survey, or on each survey sheet, the crops concerned should be named or indicated by means of symbols. In the tropics there will be included, amongst others, rubber plantations, cocoa plantations, coffee plantations, tea gardens, palm oil plantations, coconut groves, citrus orchards, cinchona plantations and banana plantations. In middle latitudes the category will include citrus orchards, orchards of deciduous fruits - such as apples, pears, plums, cherries, peaches, apricots and figs - also olive groves and vineyards of different types. The category should also be used to include the groves of 'cork oaks' (as in Portugal) and also such rare cases as plantations of pine trees grown especially for the production of resins and turpentine. The category should also be used to include such perennial crops or cultivations grown without rotation as sisal and manila hemp, but sugar cane or alfalfa, although grown on the same piece of land for a number of years, should be recorded as growing on cropland.

4. "Cropland

(a) Continual and rotation cropping (dark brown)
(b) Land rotation (light brown)

The cropland will include both plowed land and land cultivated by hand. By continual crops we mean, for example, rice, which is often the only crop grown year after year on the same land, also sugar cane and such mono-cultural crops as wheat and corn. By rotation crops we include those grown in a fixed or variable rotation, including fodder grass, clover and alfalfa, which may occupy the land for two or three years. Crop rotation includes 'current fallows', that is land which is rested for a short period (not exceeding three years). All the above are to be shown in dark brown.

By land rotation we understand the system whereby cultivation is carried on for a few years and then the land allowed to rest perhaps for a considerable period before the scrub or grass which grows up is again cleared and the land recultivated. In such areas, however, the farms or settlements from which cultivation takes place are fixed and the cultivation of the land is the dominant occupation. The secondary growth which is allowed to appear has little or no economic importance. This is in contrast to the forest with subsidiary cultivation mentioned later.

5. "Improved Permanent Pasture (Managed or Enclosed) (light green)

This is a type of land use well understood in countries like New Zealand and Britain where controlled grazing is carried on in small enclosed fields, the grass being managed by manuring, sometimes by reseeding, by liming, or in other ways. Often the grasses, including clovers, have been introduced so that the pasture is not 'natural'. Some land of this sort is grazed; other is cut for hay or dried grass. In other countries, such as the United States, this category of land is less distinctive but would include land such as the intensively stocked grasslands of the dairy belts.

6. "Unimproved Grazing Land (orange and yellow

This may be described as extensive pasture or range land. It may be enclosed in large units but is not as a rule in small fields. It is not fertilized or deliberately manured though it may be periodically burnt over. The vegetation is that which is native to the locality although the characteristics of the vegetation have often been modified by grazing or occasionally by the introduction of non-local plants.

A great range of vegetation is included, from tropical savanna to arctic tundra, and as far as possible the type of vegetation should be described on the map or accompanying notes. For example, the category will include savanna (or grassland with scattered trees where the grass is dominant), tropical grassland, (e.g. Llanos), steppe land, dry pampas, and short grass prairie. The category will also include such range lands as bunch grass and sage brush and creosote bush, as well as the vegetation of the High Veld and the Karoo of South Africa. It will include the heather moorlands and heath lands and grass moorlands of Europe. It is clear that special care must be taken to distinguish these very varied types.

There are many areas of such land which at present are not used in different parts of the world though they differ but little from those which are used for grazing. This difference should determine the color, orange for used and yellow for not used.

7. "Woodlands (different shades of green)

Forest and woodland will be found to differ very greatly from one part of the world to another. The main categories suggested refer to the morphological character of the forest, independently of the age of the tree.

(a) Dense. Forests where the crowns of the trees are touching (dark green)

(b) Open. Where the crowns of the trees do not touch and the land between is occupied by grass or other ground vegetation. Where, of course, the trees are very sparse such land comes into category 6 (grazing land) (medium green)

(c) Scrub. Is used to designate vegetation such as the maquis of Europe, chaparral of North America, mallee and mulga of Australia and the acacia thorn scrub of Africa and India (olive green)

(d) Swamp forests, both fresh water and tidal (mangrove) (blue green)

(e) Cut-over or burnt-over forest areas not yet fully reclothed. (stippled with the green of the respective color)

(f) Forest with subsidiary cultivation (green with brown dots)

(i) Shifting cultivation, where patches of land are recleared for cultivation from time to time, usually but not always, by wandering tribes.

(ii) Forest-crop economy. Somewhat similar is the sytem, for example in parts of eastern Canada, where holdings consist mainly of woodland but where some cultivation is carried on subsidiary to the working and management by replanting of the forest land.

The type of forest, whether dense, open, scrub, can usually be distinguished by symbols into the following: (e) evergreen broad-leaved, (sd) semi-deciduous, (d) deciduous, (c) coniferous, (m) mixed coniferous and deciduous. In addition, in many parts of the world it should be possible to name the dominant species or groups of trees and indicate the type of undergrowth. It may also be possible to indicate in broad outline where forest land is being commercially exploited.

8. "Swamps and Marshes (Fresh-and Salt-Water, Non-forested) (blue)

9. "Unproductive Land (grey)

A great variety of land is also included in this category. Considered in relation to land use it appears bare, and though it may support lowly forms of plant life is essentially unproductive. Barren mountains, rocky and sandy deserts, moving sand dunes, salt flats, icefields are examples. Potential use, such as land capable of irrigation, may be indicated and considered in the memoir but it is the present position which should be mapped.

"Important Note

Where land falls into two categories, as olive groves with cultivation of wheat between the trees, this should be indicated by a combination of the appropriate colours." (I.G.U., 1952).

A.2 SECOND LAND USE SURVEY OF BRITAIN CLASSIFICATION

The Second Land Use Survey of Britain was initiated in 1960 and had as its objective the complete mapping of present land use in England, Scotland, and Wales at a scale of 1:25,000. The survey was intended to revise and replace the pioneering work of Sir L. Dudley Stamp who had achieved a complete coverage of land utilization maps for all Great Britain in the decade before the Second World War. This undertaking had involved the preparation of about 20,000 six-inch field maps displaying a seven-category classification system. Stamp's experience with the first land use survey led to his preparation of a general scheme for a world land use survey. Conventional colours were laid down for nine categories of data, the scheme recognizing wide local variations, and allowed for corresponding flexibility in modes of representation.

The scheme was recommended by the International Geographical Union as a basic colour notation in the preparation of maps (A.1). Alice Coleman who directed the second land use survey on behalf of the Isle of Thanet Geographical Association, observed that the main categories or classes of land use and the colours which represent them:

> "Adhere as closely as possible to the scheme recommended by the Old World Division of the World Land Use Survey. There is only one deviation from it, in the case of settlement, but there are four additional categories: transport, open spaces, derelict land and unvegetated land." (Coleman and Maggs, 1965).

The classification scheme employed is shown in Table A.2.1. In all, 64 categories of information can be represented on 1:25,000 scale maps. Coleman recognized that:

> "The danger of showing a large number of categories on one map is that it may become impossible to see the wood for the trees. This change is eliminated ... by a decision to produce a map which can be read at two different levels of intensity. The first level consists of eleven major and two minor groups, each represented by a distinctive colour easily discerned at a first inspection. At the second level are the subdivisions of each group, which are represented by variations of tone within the main colour, or by other subdued cartographic devices. The subdivisions are clearly distinguishable from each other as soon as the map is subject to a moderate scrutiny, but they do not interfere with the unity of the 13 main groups." (Coleman and Maggs, 1965).

Those mapping land use in the field were requested to do so using six-inch maps. Mapping was to be rather more detailed than the 64 categories which would eventually appear on the photographically reduced 1:25,000 maps. This arrangement was directed primarily towards the mapping of individual crops so as to ensure that ultimately they be assigned to the correct group at 1:25,000.

The survey relied to a great extent upon the services of volunteer labour (nearly 3,000 persons in England and Wales, for example), although paid surveyors were retained to map heath and moorland vegetation, a task usually beyond the capabilities of volunteers. Each volunteer was asked to be responsible for surveying one or more six-inch maps and in England, for example, each person averaged four to five maps.

TABLE A.2.1. SECOND LAND USE SURVEY OF BRITAIN CLASSIFICATION

LAND USE GROUP	COLOUR	"DERWENT" CRAYON NO.
1. SETTLEMENT (RESIDENTIAL AND COMMERCIAL)	Grey	19 - 68
(a) Fully built-up		
(b) Houses with gardens		
(c) Recently built-up		
(d) Public buildings		
(e) Caravan sites		
2. INDUSTRY		
(a) Manufacturing industry	Red	19 - 14
(i) Non-metalliferous mining products (excluding coal)		
(ii) Chemical and allied trades		
(iii) Metal manufacture		
(iv) Engineering, shipbuilding, and electrical goods		
(v) Vehicles		
(vi) Metal goods, not elsewhere specified		
(vii) Precision instruments, jewellery		
(viii) Textiles		
(ix) Leather, leather goods, and fur		
(x) Clothing		
(xi) Food, drink, and tobacco		
(xii) Manufacture of wood and cork		
(xiii) Paper and printing		
(xiv) Other manufacturing industries		
(b) Extractive industry		
(c) Tips (active, abandoned), derelict		
(d) Public utilities (excluding war department property)		

TABLE A.2.1. (Continued)

	LAND USE GROUP	COLOUR	"DERWENT" CRAYON NO.
3.	TRANSPORT	Orange	19 - 10
4.	DERELICT LAND	Black Stipple	Indian Ink
5.	OPEN SPACES	Lime Green	19 - 48
6.	GRASS	Light Green	19 - 46
	(a) Scrub pasture		
	(b) Juncus rush pasture		
	(c) Heath and moorland pasture		
	(d) Pasture with > 50% non-pasture species		
7.	ARABLE	Light Brown	19 - 61
	(a) Ley legumes		
	Cl - red clover		
	Lu - lucerne		
	Ve - vetch		
	Sa - sainfoin		
	Tr - trefoil		
	Animals to be noted using appropriate symbol if they are found on arable crops or in orchards (e.g. H-horses, Pi-pigs, Be-bees).		
	(b) Cereals		
	W - wheat		
	B - barley		
	O - oats		
	R - rye		
	D - dredge (oats/barley mix)		
	(c) Root crops		
	Tu - turnips		
	Sw - swedes		
	KR - kohlrabi		
	FC - fodder carrots		
	Mn - mangolds		
	Sb - sugarbeet		
	(d) Green fodder		
	Ka - kale		
	Ra - rape		
	Lp - lupins		
	BB - broad beans		
	FP - fodder peas		
	Ma - mashlum		
	Mu - mustard		
	Mz - maize		
	Li - linseed		
	Ca - fodder cabbage		
	(e) Industrial crops		
	Sb - sugarbeet		
	FP - flax		
	BI - buckwheat		
	Chi- chicory		
	BMu- black mustard		
	(f) Fallow		
8.	MARKET GARDENING	Purple	19 - 23
	(a) Ordinary market gardening		
	M - mixed crops		

TABLE A.2.1. (Continued)

LAND USE GROUP	COLOUR	"DERWENT" CRAYON NO.
8. MARKET GARDENING (Cont'd) P - potatoes Br- brassien crops (b) Nurseries (c) Allotment gardens (d) Flowers (e) Soft fruit (f) Hops	Purple	19 - 23
9. ORCHARDS (a) A/ - apple Pe - pear Pl/- plum C/ - cherry Nu/- nut M/ - mixed (b) G/ - grass F/ - fallow or arable M/ - market gardening or soft fruit (c) Symbol for any animals present	Purple Stripes	19 - 23, 19 - 46 19 - 61
10. WOODLAND (a) Deciduous (b) Coniferous (c) Mixed woodland (d) Coppice (e) Coppice with standards (f) Scrub woodland	Dark Green	19 - 45
11. HEATHLAND, MOORLAND, AND ROUGH LAND (a) Unenclosed land (with little or no deliberate human tending) S - wet sphagnum E.V. - cotton grass ES - drier sphagnum and wet heath C or V or CV - heather and/or bilberry dominated Pt - brachen U - gorse, broom, etc. G - grass moor and rough grazing A - alpine heath, lichen, Rhacomitrium moss MD - unfixed dunes with marram FD - dunes fixed with grass O - heath in early stages of reversion to forest. (b) Heath and moorland, in pasture fields invaded to extent of > 50% by heath and moorland	Yellow	19 - 6
12. WATER AND MARSH (a) Open water (b) Marsh or thoroughly waterlogged land	Light Blue	19 - 32
13. UNVEGETATED LAND	White	-

A.3: CANADIAN LAND USE CLASSIFICATION

The Canadian Land Use Classification is derived exclusively from the World Land Use Classification (A.1). Canada, as a member of the International Geographical Union, recognized the intent and potential value of a land use classification and through the Geographical Branch, Department of Mines and Technical Surveys, immediately began to experiment "in pilot land use surveys in several parts of the country ... by using the sampling method and interpreting larger areas by detailed studies of typical examples" (Watson, 1952). A continuing growing interest in land use in Canada resulted in the appointment in 1959 of a Special Committee of the Senate of Canada"to consider and report on land use in Canada and what should be done to ensure that our land resources are most effectively utilized for the benefit of the Canadian economy and the Canadian people" (Debates of the Senate, Feb. 17, 1959, p. 163).

In the same year, the Geographical Branch submitted to the committee a brief which outlined a specific land use mapping program for Canada. The program called for "a systematic land use survey based upon appropriate factors to provide for an economic classification of the land according to its use suitability" (Debates of the Senate, Rept. of Spec. Comm. on Land Use, July 16, 1959, p. 1,086).

The Geographical Branch "made every effort" to follow the recommendations of the World Land Use Commission in implementing the Canadian land use mapping program (Nicholson et al., 1961). Five mapping scales were identified for the program:

1.	1:1,000,000	for most of Canada, to fulfil commitments to the IGU. examples: Land use map of southern Ontario; land use maps of 8 Canadian cities in Atlas of Canada.
2.	1:500,000	primarily for land use mapping in western Canada where large areas of similar land use require less generalization.
3.	1:250,000	for land use in sparsely settled areas where limited generalization of data will not greatly detract from the value of the final map.
4.	1:126,720	for application in Prince Edward Island.
5.	1:50,000	for land use in densely settled areas with complex land use patterns.

The land use classification procedures are in accord with the World Land Use Classification. A number of sub-categories have been identified within the major categories: 23 distinct shades have been derived from nine basic colours (Table A.3.1). Definitions and examples of the classification are provided by Nicholson et al. (1961). In 1962, the Geographical Branch published a Procedure for production of Land Use Maps (Can. Dep. Mines and Tech. Surveys, 1962). The volume identified 13 steps in land use map production, from field survey to checking of the colour proof. Legends were provided for colour classification at different mapping scales, three examples of which are shown in Table A.3.2.

TABLE A.3.1. WORLD LAND USE CLASSIFICATION AND CANADIAN LAND USE CATEGORIES

WORLD LAND USE CLASSIFICATION	CANADIAN LAND USE LEGEND
Settlements and associated non-agricultural lands (dark and light red)	Urban (red) a. Industrial (dark red) b. Commercial (bright red) c. Residential (medium red) d. Recreation (light red) e. Associated non-agricultural land (pale pink)
Horticulture (deep purple) Tree and other perennial crops (light purple)	Tree Fruits and Horticulture (purple) a. Horticulture (dark purple) b. Vineyards (medium purple) c. Orchards (light purple) d. Other - blueberries, hops, etc. (pale mauve)
Cropland a. Continual and rotation cropping (dark brown) *b. Land rotation (light brown)	Cropland (brown) a. Hay (dark brown) b. Grain (light brown) c. Other - oil seeds, potatoes (medium brown) d. Other - tobacco etc. (medium brown)
Improved permanent pasture - managed or enclosed (light green) Unimproved grazing land a. Used (orange) b. Not used (yellow)	Pasture a. Improved pasture (light green) b. Open grassland - unimproved grazing land, used** (orange) c. Scrub grassland - unimproved grazing land, unused** (yellow)
Woodlands a. Dense (dark green) b. Open (medium green) c. Scrub (olive green) *d. Swamp forests (blue green) e. Cut-over or burnt-over forest areas (green stipple) f. Forest with subsidiary cultivation (green with brown dots)	Woodlands (green) a. Dense (dark green) b. Open (medium green) c. Scrub (olive green) d. Cut-over and burnt-over (dark green stipple)
Swamps and marshes, fresh- and salt-water, non-forested (blue)	Water (blue) a. Water (blue) b. Swamps and marshes (light blue)
Unproductive land (grey)	Unproductive (grey)

*Categories that do not occur in Canada.

**The term grazing land will be used for the land-use maps of the grazing areas in the prairies and central British Columbia.

TABLE A.3.2. LAND USE LEGENDS, CANADIAN LAND USE CLASSIFICATION

	MAP AND LAND USE LEGEND		PRISMSCOLOUR PENCIL NO.
a)	Niagara Peninsula 1:50,000		
	URBAN:	Industrial Areas	928
		Commercial Areas	925
		Residential Areas	922
		Recreational Areas	930
		Associated Urban (non-agricultural) Areas	929
	AGRICULTURAL:	Hay	946
		Grain	943
		Tobacco	901
		Horticulture	932
		Vineyards	931
		Tree Fruits and Small Fruits	934
		Improved Pasture	905
	GRASSLAND & WOODLAND:	Open Grassland	918
		Scrub Grassland	916
		Dense Woodland	909
		Open Woodland	910
		Scrub Woodland	913
		Cut-over or Burnt-over Areas	909 (stipple)
	OTHER:	Swamps and Marshes	902
		Unproductive Land	936
b)	Prince Edward Island 1:126,720		
	URBAN:	Industrial Areas	928
		Commercial Areas	925
		Residential Areas	922
		Recreational Areas	930
		Associated Urban (non-agricultural) Areas	929
	AGRICULTURAL:	Hay	946
		Grain	943
		Potatoes	942
		Horticulture	932
		Orchards	934
		Blueberries	931
		Improved Pasture	905
	GRASSLAND & WOODLAND:	Open Grassland	918
		Scrub Grassland	916
		Dense Woodland	909
		Open Woodland	910
		Scrub Woodland	913
		Cut-over or Burnt-over Areas	909 (stipple)
	OTHER:	Swamps and Marshes	902
		Unproductive Land	936
		Areas leased for Oyster Beds	Black ink

TABLE A.3.2. (Continued)

MAP AND LAND USE LEGEND		PRISMACOLOUR PENCIL NO.
c) Prairie 1:500,000		
URBAN:	Built-up Areas	925
	Associated Urban (non-agricultural) Areas	929
AGRICULTURAL:	Cropland	946
	Horticulture	932
	Improved Pasture	905
	Open Grassland	918
	Scrub Grassland	916
WOODLAND:	Dense Woodland	909
	Open Woodland	910
	Scrub Woodland	913
	Cut-over or Burnt-over Areas	909 (stipple)
OTHER:	Swamps and Marshes	902
	Unproductive Land	936

LAND USE CLASSIFICATION GROUP B

B.1: CANADA LAND INVENTORY, LAND CAPABILITY, AND LAND USE CLASSIFICATION (primary system)

The Canada Land Inventory (CLI) is a comprehensive survey of land capability and land use which has a broad objective: "to classify lands as to their capabilities; to obtain a firm estimate of the extent and location of each class and to encourage use of CLI data in planning" (Canada, Environment, 1978a). Lands are classified according to:

1. their physical capability for use in agriculture, forestry, recreation, and wildlife;
2. their present use.

A system for classifying and mapping the capabilities of waterbodies for sports/fish also was developed. While map data have been prepared for use by planners, printed maps will not be produced. The CLI also had as an objective socio-economic land classification through the application of statistical data which is available from Statistics Canada. This latter capability, stated Rees, "would enable planners to relate socio-economic factors and historic land-use patterns to the physical capability data for a given region, an essential requirement for any comprehensive planning process". An agro-climatic classification for the purposes of delineating climatic zones significant for crop production; a national biophysical land classification; the development of a system permitting concise and compact data storage; and pilot land use projects completed the range of activities to be engaged in as part of the CLI. "The overall C.L.I. program comprised at least theoretically, a formidable set of new tools to achieve the goal of rationalizing resource and regional planning in Canada" (Can. Fish. and Environment, 1977).

The CLI was formally initiated on October 3, 1963 as a comprehensive federal-provincial program under the Agricultural Rehabilitation and Development Act (ARDA) of June, 1961 (amended to Agricultural and Rural Development Act in May, 1966). The areas covered by the CLI are the settled portions of rural Canada and adjacent land areas which affect the income and employment opportunities of rural residents. Detailed information on the inventory will be found in McClellan (1965), McClelland, Jersak, and Hutton (1968), Symington (1968), and the CLI Report Series (14 volumes, 1965-1978) available from the Lands Directorate, Environment Canada, Ottawa.

The impetus for the passage of ARDA and for the establishment of the CLI came after the Second World War when there was evidence of growing regional economic disparity, widespread misuse of land, and a range of resource and land use conflicts. Many of these problems generally could be associated with the rapid urbanization of Canada's population. The problems also were apparent on a global scale and had inspired the organization of the World Land Use Survey and associated classification (A.1) and, soon after, the Canadian Land Use Classification (A.3) which was being employed at a mapping scale of 1:50,000. The recommendations emanating from both the Senate of Canada Special Committee on Land Use (1959) and the "Resources for Tomorrow" Conference of 1961 served to focus attention in Canada on the need for inventories of land use and assessments of the capability of land to sustain various types of land use.

The division of responsibilities agreed to in principle between the federal and provincial governments for the implementation of the CLI was as follows:

The Government of Canada agreed to:

- sponsor and co-ordinate the planning, development, and publication of the inventory; and
- finance all additional expenditures required of the provinces in the conduct of the inventory;
- foster the development of national classification systems and criteria for their application through co-operative work of federal and provincial agencies;
- provide technical assistance to the provinces in the conduct of the inventory, through the co-operative work of federal research personnel and provincial staffs in related fields;
- provide interprovincial co-ordination of survey methodology and presentation of results;
- provide a system for data processing and map compilation as required in the inventory; and
- undertake the publication of results as required, on a national basis, at the map scale of 1:250,000.

The Provincial Governments agreed to:

- undertake the planning, development, and conduct of the inventory within the province, with the financial and technical assistance of the Federal Government;
- establish a Provincial Inventory Committee to provide technical and administrative co-ordination for the inventory within the province;
- develop a provincial plan for inventory work;
- conduct the inventory with technical and financial assistance provided by the Federal Government;
- undertake publication of results of the inventory which may be of particular interest to the province; and

- provide the Federal Government with all inventory data required for compilation and publication of results on a national basis.

The total area to be covered by the CLI approximates one million square miles. For the purposes of land use capability these lands have been evaluated, classified, and mapped separately for each of the resource sectors under consideration. The mapping data were compiled from soil surveys, maps, other sources of published information, aerial photographs, and field studies in selected areas. Seven classes of land ranging from very high (Class 1) to almost no capability (Class 7) were identified for each sector.

> "For the agricultural, forestry and wild life components, the classes are based on the degree of limitation (biological, climatic, physical) of the resource base affecting productivity in the sector under consideration. For example, in the agricultural sector, Class 1 land would have no significant limitations for the production of a wide variety of field crops, while Class 7 lands have such severe limitations that there is no capability for arable culture, or even for permanent pasture. Subclasses in these sectors (except in Class 1 where there are no subclasses) are identified by specifying in code symbols the major types of <u>limitations</u> for each class.
>
> "In the recreational sector, on the other hand, classes were established on the basis of the intensity (quantity) of outdoor recreational use which might be sustained per unit area, i.e., on the basis of positive resource attributes. Here, subclasses indicate the specific features of the resource providing <u>opportunity</u> for recreational use. This structural inconsistency and the implicit difference in perspective between resource analysts in the recreation sector relative to the other components is worth emphasizing ... It contributes to the difficulty in making trade-offs and other comparisons in resource allocation among sectors, discussed more fully in a later section.
>
> "The product of the capability mapping program consists of five map sheets for each geographic area covered by the inventory (one for each resource sector including separate maps for ungulates and waterfowl), and is intended to provide a basic physical input to the regional land-use planning process on a broad scale or 'reconnaissance' level. Special considerations sometimes required differences in format between provinces. For examples, because of British Columbia's highly variable topography, maps in the Forestry and Agriculture Sectors for that province are published at a scale of 1:125,000 by special agreement with Ottawa (compared to 1:250,000 for other sectors and areas). While these scales represent the minimum requirement for data compilation, it should be pointed out that soils, biophysical and landform information for some areas are stored at a much finer scale in the provincial C.L.I. data base files." (Can. Fish. and Environment, 1977).

The preparation of a classification for the present land use component of the CLI depended on two factors: the types of information which were required; and the extent to which land use mapping to the time of the CLI could be incorporated into the inventory. The classification was designed to provide two types of information:

1. it is an estimate of the location and extent of major land uses; and

2. it provides for a comparison between present use and assessed capability of land, a goal which is attained by matching the land use maps against the capability maps produced in other sectors of the inventory.

Because of the considerable amount of land use mapping which had been completed or was in progress at the time the CLI was initiated, the present land use classification "was designed so that most existing land-use

maps could be used with a minimum of re-interpretation" (McClellan, 1965). The Canadian Land Use Classification (A.3) which was then in use was accordingly modified to the classification shown in Table B.1.1.

There are a number of limitations to the land use classification that were recognized at an early date in the program:

> "For anyone using maps embodying the land-use classification it is important to realize what the maps do not show, as well as what they do show. The maps do not purport to be all-inclusive in their description of the present position. They do not reveal any of the socio-economic factors intimately related to use of the land, such as size of farm units or type of land tenure. Alone they reveal very little about land capability. Prime agricultural land may be covered by woodland; this fact will emerge only when the present land-use maps are compared with the soil capability maps. Nor do the maps reflect degrees of productivity within categories; the lush pastures of the lower Fraser valley in British Columbia appear in the same category as the weedy timothy fields of the part-time farmers along the margin of the Canadian Shield. The present land-use classification is simply an attempt to determine the area and show the location of the major uses of land across the country.
>
> "The major defect in the classification is one that is common to most present land-use classifications. It relates to the nature of the last four categories. In reality these are not 'use' categories, but rather, 'cover-type' categories. Thus, the actual use of woodland may be for grazing, or much of the unimproved pasture land may have no use at all - as in the case of idle land held for speculation around the edges of cities, or abandoned farmland reverting to bush along the margins of the Canadian Shield. In many cases, the determination of actual use in these categories could only be accomplished through extensive field work and interviewing. As this is not feasible if the maps are to be completed within the allotted time, it must be accepted that for some categories no specific use can be assigned with any degree of certainty." (McClellan, 1965).

In 1967, the CLI classification was extended to cover pilot projects in land use planning. Very few methodological specifications have been laid down for the projects, but certain general conditions must be met before proposals for land use planning studies are approved.

Two final remarks concerning the CLI are in order. The first concerns biophysical land classification and the second, the Canada Geographic Information System (CGIS). Early in the CLI program there was a perceived need for land inventory and classification systems based on any displayed biological and physical (geoclimatic) features of the land resource without reference to any particular land use. Accordingly, a national biophysical land classification program was designed to "differentiate and classify ecologically significant segments of the land surface rapidly and at a small scale" (Lacate, 1969). As to the CGIS this computerized data storage, processing, and retrieval system was essential for the acceptance of data from both maps and statistical tables for efficient storage and retrieval (Can. Environment, 1973, 1977a and b).

> "... the present C.G.I.S. is capable of manipulating any data with characteristics similar to those of the C.L.I., i.e., map data composed of bounded areas (any closed polygons) and a description for each polygon (see Canada (undated) for details). If required, the system can store data for points and lines and interface the latter with that for areas. The C.G.I.S. accepts map data at scales of 1:370 to 1:10^8 in the Universal Transverse Mercator (U.T.M.) projection. Output maps are generated at any scale in U.T.M..
>
> "As required, the system is capable of comparing and correlating data from stored coverages within areas through a

TABLE B.1.1. SUMMARY OF CLASSIFICATION FOR CANADA LAND INVENTORY PRESENT LAND USE

CATEGORY	LAND USE	SYMBOL
I	URBAN. Land used for urban and associated non-agricultural purposes.	
	1. Built-up Area. (Parks and other open spaces within built-up areas are included.)	B
	2. Mines, Quarries, Sand and Gravel Pits. (Land used for the removal of earth materials.)	E
	3. Outdoor Recreation. (Golf courses, parks, beaches, summer cottage areas, game preserves, and historical sites.)	O
II	AGRICULTURAL LANDS.	
	1. Horticulture, Poultry, and Fur Operations. Land used for intensive cultivation of vegetable and small fruits including market gardens, nurseries, flower and bulb farms, and sod farms. Large scale commercial fur and poultry farms are also included because of their specialized agricultural nature.	H
	2. Orchards and Vineyards. Land used for the production of tree fruits, hops, and grapes.	G
	3. Cropland. Land used for annual field crops: grain oilseeds, sugar beets, tobacco, potatoes, field vegetables, associated fallow, and land being cleared for field crops.	A
	4. Improved Pasture and Forage Crops. Land used for improved pasture or for the production of hay and other cultivated fodder crops including land being cleared for these purposes.	P
	5. Rough Grazing and Rangeland.	K
	(a) Areas of natural grasslands, sedges, herbaceous plants, and abandoned farmland whether used for grazing or not. Bushes and trees may cover up to 25 per cent of the area. If in use, intermittently-wet, hay lands (sloughs or meadows) are included.	
	(b) Woodland grazing: If the area is actively grazed and no other use dominates, in some grassy, open woodlands, bushes and trees may somewhat exceed 25 per cent cover.	
III	WOODLAND. Land covered with tree, scrub, or bush growth, including:	
	1. Productive Woodland. Wooded land with trees having over 25 per cent canopy cover and over approximately 20 feet in height. Plantations and artificially reforested areas are included regardless of age.	T
	2. Non-Productive Woodland. Land with trees or bushes exceeding 25 per cent crown cover, and shorter than approximately 20 feet in height. Much cut-over and burned-over land is included.	U
IV	WETLAND.	
	Swamp, Marsh or Bog. Open wetlands, except those which frequently dry up, and show evidence of grazing or hay cutting. (See K Agricultural Lands.)	M
V	UNPRODUCTIVE LAND. Land which does not, and will not, support vegetation. e.g. eroded soil or rock and active depositional features.	
	1. Sand. (Sand bars, sand flats, dunes, beaches.)	S
	2. Rock and Other Unvegetated Surface. (Rock barrens, badlands, alkali flats, gravel bars, eroded river banks, mine dumps.)	L
VI	WATER.	Z

program called Overlay. Thus data from one set of polygons (e.g. agricultural capability) may be superimposed on information drawn from another (e.g. census tracts), and corresponding cross-tabulations produced. Up to eight coverages may be overlaid simultaneously, and additional 'layers' can be generated (if necessary!) by superimposing subsequent overlay operations. Users may also manipulate the overlay data base in various other ways - for example, maps of any combination of the variables included in a given operation, may be produced.

"In general, output from the C.G.I.S. system can be in map, tabular, or digital form depending on the requirements of the user. Additional operational flexibility is achieved through 'interactive retrieval' of maps and tables whereby the latter are displayed by Cathode Ray Tube (C.R.T.) at a keyboard entry terminal 'while you wait'". (Can. Fish. and Environment, 1977).

B.2: APPLICATION OF THE CANADA LAND INVENTORY PRESENT LAND USE CLASSIFICATION IN MANITOBA

As noted in Classification System B.1, the Canada Land Inventory was expanded in 1967 to cover pilot projects in land use planning (PLUP). In these projects, federal government resource departments continued to be responsible for overall co-ordination of the CLI and the publication of maps, but administration of the program varied among the provinces. In the case of the Province of Manitoba, both federal and provincial agencies contributed to the Application of the Present Land Use Classification ... (Hodgson and Hiller, 1973) which was initiated in 1966. Management of the project was the responsibility of the provincial CLI group which, in turn, was administered by the Manitoba Department of Mines and Natural Resources.

Because only relatively old air photography was available for much of Manitoba, field mapping from fixed-wing aircraft and autos was conducted, together with photo interpretation of those areas with recent air photography. Large areas of native vegetation were mapped by air-photo interpretation, and extensive use was made of forest inventory cover-type maps for mapping native vegetation. Land use information was plotted directly onto air-photo mosaics which then were used as base maps. Once all parcels of land had been classified, the mosaic was reduced and the land use information traced directly onto a 1:50,000 scale mylar base map.

Each of the land use categories is discussed in detail in the manual. The classification followed is that of the CLI present land use classification and "although there was some difficulty encountered with terminology of the classification, the original category designations were retained" in the manual. A summary of the manner in which the classification was employed is shown in Table B.2.1. The conversion of forest inventory cover-type classes to the present land use classification is shown in Table B.2.2.

TABLE B.2.1. APPLICATION OF CLI PRESENT LAND USE CLASSIFICATION IN MANITOBA

CATEGORY	LAND USE	MAP SYMBOL
1.	**URBAN LAND USE**	
a)	**Built-up Areas** Includes all compact settlements, villages, towns, and cities, non-agricultural open spaces in settlements (e.g. vacant lots); commercial, industrial, and other associated urban features (e.g. grain elevators, cemeteries, sewage lagoons) which are separate from a compact settlement; and surrounding grounds, storage sheds, and parking lots connected with these establishments. Examples of types of isolated units mapped as part of the built-up class: oil refineries; warehouses; auto wrecking yards; shopping centres; Stony Mountain Penitentiary; military camps; mine buildings; pulp & paper mills; developed power sites; schools; transportation facilities Many features too small to appear on map (e.g. radio towers, forestry fire towers, Manitoba Hydro power transformer sites) included in the surrounding land category. Farmlands associated with above isolated built-up features (e.g. Stony Mountain Pen.) are placed in appropriate class. Farm buildings are not included as part of the built-up class, but are mapped as part of adjoining agricultural land in recognition of their dominant agricultural function.	B
b)	**Mines, Quarries, Sand and Gravel Pits** Includes all land areas being used (or which were used) for extraction of earth minerals, buildings associated with these operations, and land held in reserve for future excavations. Buildings associated with underground mining formed part of built-up category (B). Types of operations included: Commercial mineral extraction (e.g., clay pits of Fort Whyte Cement Plant, excavations for bentonite in Miami area) Limestone and gypsum quarries (e.g. at Garson, Steeprock, and near Gypsumville) Sand and gravel pits, usually excluding numerous excavation sites along highways. Abandoned excavation sites with a vegetative cover are classified as Rough Grazing or Woodland. Peat extraction (e.g. Julius Bog) Commercial topsoil removal is to be included in this category.	E
c)	**Outdoor Recreation** Includes all private and public land utilized for outdoor recreation, but excludes recreation sites within built-up area (B) (e.g., parks and race tracks). In latter instance only sites adjacent to or outside the limits of a town are mapped as Outdoor Recreation. Includes total area within boundaries of national, provincial, municipal, and private parks, land occupied by summer cottages, developed bathing beaches, summer camps, fishing and hunting resorts, wildlife sancturaries, non-military shooting ranges, race tracks, golf courses, developed ski slopes, marinas, and drive-in theatres.	O

TABLE B.2.1. (Continued)

CATEGORY	LAND USE	MAP SYMBOL
	Other recreational use sites fall within this category but cannot always be included on maps because of their small size (e.g., roadside parks, picnic areas, historic sites). Only those close to the minimum size limitation (6.4 acres) are mapped.	
2.	HORTICULTURE, FUR, AND POULTRY OPERATIONS Includes all specialized agriculture and agricultural related activities (e.g., nurseries, experimental farms, fur farms, sod farms, piggeries, and large-scale poultry operations) but due to the nature of some of these, especially the latter three, and mapping techniques used, a substantial number of these types of activities remained unmapped. The original classification also included market gardens and truck farms which were to be mapped separately from farms growing vegetables as part of a standard crop rotation practice or for vegetable canning plants. Latter to be mapped as cropland (A). Because of difficulty in differentiation, all vegetables have been arbitrarily mapped as cropland.	H
3.	ORCHARDS AND VINEYARDS No representative units of this category exist in Manitoba.	G
4.	CROPLAND Includes all land used for the production of annual field crops, i.e., grain, oil seeds, sugarbeets, potatoes, and other vegetables; land under summerfallow; land in process of being cleared and which appeared likely to be used for annual field-crop production. It is recognized that some grain crops (oats, fall rye, barley) are grown for hay or pasture in certain cases. All fields growing cereal grains are placed in this use category since confirmation of use for hay or pasture would require extensive interviewing.	A
5.	IMPROVED PASTURE AND FORAGE CROPS Includes, improved permanent pasture; pasture used as part of crop rotation; all fodder crops, forage legumes, hay and other forage crops, whether grown for forage or used for seed; and land being cleared and which appears to be intended for use as pasture or fodder. Some haying lands prove difficult to map, in relation to separating improved hay lands from those areas of native grasslands being cut for hay. Red River Floodway mapped in this category. While primarily for flood protection, it is also important for forage production.	P
6.	ROUGH GRAZING AND RANGELAND Includes all tracts of natural grassland whether grazed, ungrazed, or cut for fodder and characterized by absence of evidence of cultivation. An area may have up to 25 per cent cover of shrubs or trees and remain classified as Rough Grazing and Rangeland. CLI-PLU manual states wooded areas used for grazing to be included in this class. In practice, these areas have been placed in their respective woodland category as it is difficult to determine from air-photo interpretation or by field survey from aircraft whether or not area is grazed.	K

TABLE B.2.1. (Continued)

CATEGORY	LAND USE	MAP SYMBOL
	Former agricultural land that had been abandoned and now in process of reverting to native state is placed in this class. Also included are intermittently wet haylands used for hay cutting or grazing when they are sufficiently dry. Community pastures mapped as to cover type rather than by placing a large block of land under the same symbol.	
7.	WOODLAND This category is subdivided into Productive Woodland and Non-productive Woodland. When possible forest inventory cover type maps have been used and the cover type designation generalized to the appropriate Productive and Non-productive category (see Table B.2.2).	
	a) Productive Woodland The original classification required that areas mapped as productive woodland were those on which tree crown cover or canopy density exceeded 25 per cent and on which the bulk of the trees could be used as sawlogs, pulpwood, fence posts, or fuel wood or commercial value at the time of photography or field work. Most of these trees are over 20 to 30 feet in height. The arbitrary minimum height range is the main criteria for determining productive woodland. Stands of trees, within this range and higher, which cover an area large enough to map, have been placed in productive woodland class. Artificially restocked areas automatically have been included in this category regardless of height. This affected classification of large tracts of land in S.E. Manitoba which are under tree plantations.	T
	b) Non-Productive Woodland Land supporting a growth of short trees or bushes. Includes willow, alder, saskatoon, sumac, immature or stunted stands of trees. Vegetation is generally less than 25 to 30 feet. Includes all forested areas burned within previous ten years, all recently logged-over areas, and parcels of agricultural land in the process of reverting to shrub cover. Wetlands with a cover of bushes less than four feet were not to be included in this category, but rather that of Wetlands (M). These situations proved difficult to interpret and would have required detailed ground checking. Therefore, unless water was visible, these areas were classified as non-productive woodlands.	U
8.	SWAMP, MARSH OR BOG Includes all wetlands covered with swamp, marsh, or muskeg type vegetation; and intermittent sloughs.	M
9.	UNPRODUCTIVE LAND	
	a) Sand Flats, Dunes, and Beaches	S
	b) Rock and Other Unvegetated Surfaces	L
10.	WATER Includes all permanent water bodies (lakes, rivers, reservoirs, potholes) which are large enough to appear on the land use map.	Z

TABLE B.2.2. CONVERSION OF THE FOREST INVENTORY COVER TYPE CLASSES TO THE PRESENT LAND USE CLASSIFICATION

The Present Land Use Sector (Manitoba) made extensive use of the Forest Cover Type map in classifying the areas of native vegetation in the Interlake, the Duck and Porcupine Mountains and the northern portion of the Canada Land Inventory area in Manitoba. The Forest Inventory classification consists of vegetation cover type units (or productivity units) each having a unique numeric code.

The "Treed Units", with codes from 1 to 699, have been assigned sub-codes by the Forest Inventory Branch. These sub-codes are as follows:

Crown Closure	Code
0-9%	0
10-30%	1
31-50%	2
51-70%	3
71% and over	4

Cutting Class	Code
Not restocked	0
Restocked	1
Young (30' and 3.5" dbh)	2
Immature Merchantable	3
Mature Thrifty	4
Overmature	5

From this information, the Present Land Use "T" and "U" categories were determined. In order for a unit to be "T", the crown closure had to be at least 2 and the cutting class at least 3. Conversely, a unit became "U" if either the crown was 1 (or less) or the cutting class was 2 (or less).

On this basis, the "Forest Cover Type" classification was converted to the "Present Land Use" (P.L.U.) classification in the following manner:

Productivity Unit	Code	Corresponding P.L.U. Code
Treed areas	1-699	T or U (explained above)
Treed muskeg	700	U
Treed rock	710	U
Willow and alder	720	U
Barren bare rock	800	L
Cultivated field	810	-
Brush and scrub (on private land)	815	U
Meadow	820	K
Marsh, muskeg	830	M
Unclassified	840	-
Water	900	Z

Cultivated fields and unclassified areas not assigned a corresponding Present Land Use code were photo interpreted to complete the inventory.

B.3: MANITOBA RURAL LAND USE CLASSIFICATION

The Manitoba Department of Municipal Affairs, Municipal Planning Branch, has employed a modified version of the Canada Land Inventory (CLI) Present Land Use Classification in its rural land use mapping program. (This is distinct from the department's one level, 24-category number and colour-coded general land use classification used for urban land use mapping at scales of 1:2,500 or 1:5,000). The following classes of land use are to be identified in mapping a city-centred regional study area:

1. Built-up areas
2. Individual farm and non-farm rural residences
3. Mines, quarries, and gravel pits
4. Market gardens
5. Cropland, forage crops, improved pasture
6. Rough grazing and rangeland
7. Feedlots
8. Woodland
9. Swamps, marshes and bogs
10. Miscellaneous unique features such as airfields, sewage lagoons, solid-waste disposal sites, hydro, gas and oil pipeline corridors, and abandoned railway lines.

The senior rural planner of the Branch, John Friesen, noted in January, 1977 (pers. comm.) that there should be greater emphasis in identifying the type of commercial activity represented in the farming areas. In mapping the farmstead site, for example, there should be some indication as to the type of commercial operation taking place, be it grain growing, livestock raising, special crops, or some combination of these. The Municipal Planning Branch seemingly attempted this more-detailed mapping for a rural municipality as part of a municipal road study.

In the same year, Underwood, McLellan and Associates Limited (1977) completed the Brandon Land Use Mapping Project for an area of about 2,500 square miles. The area examined included several rural municipalities and four townships of the Municipality of Saskatchewan. The principal data source for the project was false-colour photography. Types of land use were determined using these photographs in conjunction with 1970 CLI data. Boundaries for the various land use types were recorded on black-and-white photo mosaics produced from the 1976 photography. Selected field reconnaissance provided a ground check for the project.

The Brandon region was classified using the following units (i.e., a modification of the CLI Present Land Classification):

	Symbol
Built-up areas	B
Farm residence	F
Non-rarm residence	NF
Mines, quarries, and gravel pits	E
Market gardens	H
Cropland, improved pasture, and forage crops	A/P
Rough grazing and rangeland	K
Woodland (not subdivided)	T/U
Swamps, marshes, and bogs	M
Outdoor recreation areas	O

Other miscellaneous unique features (e.g. feedlots, airfields, sewage lagoons, hydro corridors, waste disposal sites) were labelled as such on the mosaic sheets. Land use units less than 10 acres in size (including miscellaneous unique features) were not identified on the mosaics.

The consultant reported that it was not possible to ascertain whether or not farm residences (F) were occupied at the time of

false-colour photography because of the scale used. Two land use trends were identified when this classification was compared to the 1970 CLI one:

1. Built-up urban areas (B) are increasing in size at the expense of cropland, improved pasture and forage croplands (A/P);

2. Rough grazing and rangeland (K) are decreasing in area in the region as they are converted to Croplands, improved pastures or forage croplands (A/P).

B.4: PILOT LAND USE PLANNING (PLUP) THE PAS, MANITOBA

In 1971-72 the Pasquia area of Manitoba, centred on the community of The Pas, was the subject of a detailed land use survey. The project was initiated as part of the Pilot Land Use Planning (PLUP) Project and the work undertaken by the Present Land Use sector of the Canada Land Inventory (Hiller, 1972). A scale of 1:48,000 was selected for the map thereby permitting individual land use categories to be adequately portrayed.

During the survey, emphasis was placed upon the agricultural components of the Pasquia area and only that native vegetation lying in proximity to agricultural land was included in the mapping exercise. In all, the survey covered about 110,000 acres.

An air-photo mosaic of the Pasquia area was prepared at a scale of 4 inches: 1 mile. The mosaic was then reduced to 1:48,000 and a positive obtained. A ground survey took place in early August when both cereal and forage crops were headed out and readily identifiable. Most fields and land use features were identified from roads and rights-of-way and where ground access was difficult, sites were interpreted from aerial photography.

The classification system devised for the survey was one in which each assigned three-digit numbers denoted a specific land use for each parcel of land, not merely a cover type (Tables B.4.1 and B.4.2). The classification described land use exclusively from an agricultural point of view. For example, with respect to areas under tree cover, emphasis was placed upon whether or not the area was grazed, rather than upon the commercial, wildlife, or other value of the tree stand. Cultural features were denoted with a two-digit code.

TABLE B.4.1. CLASSIFICATION OF CULTURAL FEATURES

CULTURAL FEATURES		CODE
Farm-yards		
Occupancy Status	Occupied	01
	Unoccupied	02
Specialized Farming	a) Feedlot	04
	b) Dairying	04
	c) Poultry	04
Dugouts	Used	06
	Unused	07
Public Service		
Cemetery		10
Communication Tower		11
Refuse Dump		12
Industry		
Sand and Gravel		
a) Pit (used or abandoned)		21
b) Stock Pile		21

TABLE B.4.2 LAND USE CLASSIFICATION SYSTEM FOR THE PASQUIA AREA CROP TYPES

LAND USE	NUMBER SERIES	CROP TYPES	CODE
CEREAL CROPS	101 - 110	Wheat	101
		Barley	102
		Oats	103
		Rye	104
		Flax	105
SPECIAL CROPS	111 - 120	Rape	111
		Buckwheat	112
		Potatoes	113
		Corn	114
		Field Peas	115
		Sugarbeets	116
		Sunflowers	117
		Market Gardens	118
FORAGE CROPS	121 - 130	Alfalfa	121
		Timothy	122
		Brome	123
		Sweet Clover	124
		Alsike Clover	125
		Millet	126
		Fescue	127
MISCELLANEOUS	131 - 140	Sod	131
		Summerfallow	132
		Summerfallow*	133
MIXED CROPS	141 - 150	Timothy and Brome	141
		Alfalfa and Brome	142
		Oats and Barley	143
		Wheat, Oats, and Barley	144
		Barley and Flax	145
		Alfalfa, Timothy, and Brome	146
		Brome and Fescue	147
		Brome and Alsike	148
		Alfalfa and Timothy	149
CULTIVATED GRASSES	201 - 300	Grazed (including all varieties)	201
NATIVE GRASSES	301 - 400	Grazed	301
		Ungrazed	302
		Cut for Fodder	303
SCRUB GRASSLAND	401 - 500	Grazed	401
		Ungrazed	402
TREED GRASSLAND	501 - 600	Grazed	501
		Ungrazed	502
SCRUB	601 - 700	Grazed	601
		Ungrazed	602
WOODLAND	701 - 799	Grazed	701
		Ungrazed	702
MARSH	800		800
PERMANENTLY OPEN WATER	900		900

* A number of fields, harvested the previous fall, appeared in a derelict condition, and since showing no indication of being cultivated to date of mapping, were assigned the modified summerfallow code 133.

B.5: BRITISH COLUMBIA PRESENT LAND USE CLASSIFICATION

The fourteen categories which make up the Canada Land Inventory Present Land Use classification (B.1) have been adopted for the Present Land Use Project in British Columbia with two exceptions. These exceptions are:

1. "Woodland is divided into four types compared to two presented in the original national classification; and
2. "The Unimproved Pasture and Rangeland category is subdivided to enable Forest Range to be identified separately. The inclusion of Forest Range is the only instance where a multiple use is recognized."

The federal mapping symbols, except for the Cropland-Pasture complex, are single letter (e g., A); and a subscript is used for provincial categories, with an extra letter added for Forest Range (e.g., T, K for Forest Range within Mature Production Woodland). The classification is shown in Table B.5.1.

The British Columbia Land Inventory contains the following observations about the Cropland-Pasture Complex and Forest Range:

> "Cropland-Pasture Complex: In British Columbia the Cropland-Pasture Complex is used for all the province except for the Peace River District and the Creston Flats. The national classification recognizes that in many areas, particularly those with a livestock emphasis, it is impossible to separate Cropland from Improved Pasture and Forage Crops. In such areas forage crops and feed grains are usually grown in rotation with location of the two categories shifting each year. The problem is compounded when photographs used for interpretation were flown early or late in the growing season. "The subscript is determined by a cropland-pasture ratio derived from the most recent census of Agriculture and applied on a census subdivision basis. The cropland component was determined by adding together the census returns for the total crops and summer fallow, and subtracting total tame hay, oats for hay, corn for ensilage, other fodder crops and tree and small fruits. The pasture component consists of improved pasture plus total tame hay, oats for hay, corn for ensilage and other fodder crops.
>
> "Forest Range: Throughout a considerable area of British Columbia forest land and natural grassland are used as stock grazing areas. These areas are a necessary part of the cattle economy of the province. Information relating to the distribution of this type of dual purpose land use is mainly obtained from grazing permits and grazing leases, although evidence obtained during field checking supplements the formal information. It should be noted that this is probably the first real attempt at delineating forest range areas in the province. Attention is drawn to the wording in the classification on "these are classified as range if there is evidence or knowledge of grazing activity."

Some additional features of the classification are worthy of note:

1. "The Built-up Areas category includes military reserves, railroad yards, freeways and other isolated units as well as settlement clusters.
2. "The Open Grassland category covers a wide range of cover types from reverted or abandoned farmland, through powerline right-of-ways, sagebrush, rangeland, natural meadows, alpine meadows to thinly vegetated talus slopes.
3. "The main distinction between categories S and L is made on the basis of whether the feature was depositional or erosional."

Because of British Columbia's distinctive physiographic character, the ready availability of forest-cover maps, and the linear and intermittent nature of agricultural land, CLI mapping methods have

TABLE B.5.1. BRITISH COLUMBIA PRESENT LAND USE CLASSIFICATION

CATEGORY	LAND USE	MAP SYMBOL	EAGLE PRIMACOLOUR NUMBER
1.	Urban. Land used for urban and associated non-agricultural purposes.		
	a. Built-up Areas. Land occupied by the built-up portions of cities, towns and villages, as well as isolated units away from settlements, such as manufacturing plants (e.g. gas processing), railyards, and DND property. Open fields and parks within built-up areas are included.	B	922
	b. Mines, Quarries, and Gravel Pits. Land used now or in the past for the extraction of earth materials.	E	928
	c. Outdoor Recreation. Land used for private or public outdoor recreational purposes. Summer cottages and associated beach areas, parks, and golf courses are included.	O	930
2.	Horticulture. Land used for the intensive production of vegetables and small fruits. Market gardens, nurseries, flower-growing areas, and sod farms are included.	H	931
3.	Orchards and Vineyards. Land used for the production of tree fruits and grapes.	G	934
4.	Cropland. (Only used in Peace River and Creston Flats) Land used primarily for cash crops, usually in rotation but including both cash and feed grains. Oilseeds, sugar-beets, potatoes, field vegetables, associated fallow and land in the process of being cleared for cultivation are included.	A	943
5.	Improved Pasture and Forage Crops. Land used mainly for the production of improved pasture, hay, and other forage crops. Cultivation and planting have occurred in a recent year.	P	905
4,5.	Cropland - Pasture Complex. Where large blocks of Categories 4 and 5 cannot be distinguished, the following complexes are shown on the land use maps:		
	95.0 - 100% Cropland	A	943
	75.0 - 94.9% Cropland	A_1	943
	50.0 - 74.9% Cropland	A_2	943
	50.0 - 74.9% Improved Pasture & Forage Crops	P_2	905
	75.0 - 94.9% Improved Pasture & Forage Crops	P_1	905
	95.0 - 100% Improved Pasture & Forage Crops	P	905
	The subscript is determined by use of a "Cropland/Improved Pasture and Hay" ratio derived from the 1961 or 1966 Census of Agriculture and applied on a census subdivision basis. Census subdivisions are subdivided into two or more parts with different symbols only where it is known from other sources or from the photos that significant differences do exist within the subdivision.		

TABLE B.5.1. (Continued)

CATEGORY	LAND USE	MAP SYMBOL	EAGLE PRIMACOLOUR NUMBER
6.	Unimproved Pasture and Rangeland		
	a. Open Grassland. Based on cover rather than use as not necessarily used for grazing (e.g., remote meadows). Open grassland includes grasses, sedges, herbaceous plants and scattered shrubs to four feet in height. Abandoned farms and intermittently wet hay land (sloughs) are included.	K	918
	b. Open Woodland Forest Range. These are classified as pasture and range if they are on, or contiguous with, occupied farmland or if there is evidence or knowledge of grazing activity. They are also given a woodland classification (e.g. T2K).	K	918
7.	Woodland.* Land covered with tree or scrub growth.	T_1	909**
	a. Mature Productive Woodland. Land bearing a productive forest type with at least one tree per acre greater than 11.1" d.b.h.		
	b. Immature Productive Woodland. Productive forest land with immature cover.	T_2	909**
	c. Non-Productive Woodland on a Productive Site. Forest land which has been logged, burnt, or diseased and has either not been satisfactorily restocked or has been restocked by a non-commercial type.	U_1	903
	d. Non-Productive Woodland on a Non-Productive Site. Land bearing a non-productive type on a non-productive site.	U_2	911
8.	Swamp, Marsh and Bog. Open wetlands except for those with evidence or knowledge of haying or grazing in the drier years.	M	902
9.	Unproductive Land. Land that is biologically unproductive in its present state.		
	a. Sandflats, Dunes, and Beaches. Depositional features with exposed sand surfaces predominating.	S	946
	b. Rock and Other Unvegetated Surfaces. Badlands, eroded river banks, rock barrens, etc.	L	936
10.	Water Surfaces. Excluding temporarily flooded hay meadows, etc.	X	901

* Woodland cover is derived from the most recent Forest Cover Maps that were available at the time of mapping. The year-date(s) of the Forest Cover Maps are shown at the foot of each Present Land Use Map.

** Either T_1 or T_2 is left uncoloured.

been modified from those adopted at the national level. A considerable amount of field checking of agricultural use is required and forest-inventory maps are used as bases for photo interpretation, field work, and final mapping at 1:50,000 scale. Overlays are photographically reduced to 1:126,720 for provincial use.

Land use mapping for urbanized and associated areas has been provided with a modified classification from that describe above. Table B.5.2 shows the more-detaile classification adopted for the Victoria Capital Region Study at a larger scale of 1:25,000.

A brief review of the British Columbia experience with the CLI was provided by Rees (Can. Fish. and Environment, 1977).

B.6: OTTAWA URBAN FRINGE AREA LAND USE CLASSIFICATION SYSTEM

In 1975, the Soil Research Institute, Agriculture Canada, conducted a land use survey of Nepean and Gloucester Townships which fringe the City of Ottawa, Ontario. The survey was undertaken as part of an evaluation of existing land use and land ownership characteristics of the townships. The relationship between these two elements was to be examined "in an attempt to establish coincident trends and patterns that will ultimately designate planning needs and priorities". Although spatial features were to be emphasized, in many instances time was to be directly related to distance from the city and constituted part of the visual interpretation. Reference to soils as "good" or "poor" was in terms of capability for crop cultivation and was relative to other soils within the township.

Land use types were determined primarily from aerial-photo interpretation, but, because of the large scale and relatively small area surveyed (70,000 acres at 1:25,000), field surveys also were considered desirable. This need was reinforced by the fact that there were mapping areas as small as one third of an acre. Field survey was also considered beneficial in that the information garnered was up-to-date and casual conversations with residents provided qualitative information of past and future trends in land use and ownership.

The land use classification system employed was based on the Canada Land Inventory Classification (Table B.6.1). Modifications were introduced to accommodate local conditions and the objectives of the study (Table B.6.2). The principal changes to the CLI system consisted of an increase in the number of specific agricultural categories, the addition of three classes of abandoned land, and a generalization of the woodland category. In every instance, the classification code was assigned on the basis of visible characteristics of the field at the time of the survey.

> "The division of abandoned land into three categories was performed in order to give an indication of the length of time a field had lain idle and was based on different states of natural revegetation. In order to establish a time reference for each of these conditions, a number of farmers and residents were asked to estimate the number of years since particular fields had last been cultivated. These

TABLE B.5.2. PRESENT LAND USE LEGEND FOR CAPITAL VICTORIA REGION STUDY

MAPPING SYMBOL	LAND USE
	URBAN LAND
	Residential
R_1	Residential High Density. Apartments, townhouses, duplexes, trailer parks, and any complex larger than single dwelling.
R_2	Residential Low Density. Established single family detached dwelling.
R_3	Residential Development. Post 1970 to present day.
C	Commercial. Includes shops, offices, motels, service stations.
W	Industrial. Includes wholesaling, warehousing, manufacturing and service industries.
J	Institutional. Includes educational centres, government offices, prisons, government use reserves, D.N.D., etc.
V	Vacant. Land cleared but not used.
E	Mines, Quarries and Gravel Pits. Land used now or in the past for extraction of earth materials.
Z	Utilities. Includes power stations and transformers, communication facilities, rights-of-way, water and waste facilities, etc.
Y	Transportation. Road, rail, air, water facilities including port terminals and all land associated with transportation.
	Recreation
O_1	Parks. Public and private facilities including dedicated parks and dedicated historic sites, gardens, arboretum, campgrounds, picnic sites, park, game and ecological reserves.
O_2	Indoor Recreation Facilities. Arenas, curling rinks, swimming pools, theatres, aquariums, zoos, and art galleries.
O_3	Outdoor Recreation Facilities.
	(a) Golf courses, local ski hills, race tracks, play fields (not parks), swimming pools, rifle and archery ranges.
	(b) Marine facilities: marinas, boat launching ramps, boat houses.
	(c) Beach facilities: access rights-of-way, sand beaches.
O_4	Seasonal Residences. Includes cottages, lodges, fishing and hunting camps.
	AGRICULTURAL LAND
	Horticulture. Includes subcategories of land used for intensive production of vegetables and small fruits.
H_1	Poultry and Fur Farms.
H_2	Greenhouses, Nurseries, and Tree Farms.
H_3	Flower, Bulb, Holly, Xmas Tree, and Sod Farms.
H_4	Berry Crops.
	Orchards and Vineyards. Land used for the production of tree fruits and grapes.
G_1	Grapes.
G_2	Apples and Pears.
G_3	Stone Fruits.
G_4	Hopyards and Nuts.

TABLE B.5.2. (Continued)

MAPPING SYMBOL	LAND USE
	AGRICULTURAL LAND (Continued)
	Cropland.
A_1	Field Vegetables (tomatoes, potatoes, sugarbett for seed, watermelon, corn for human consumption, and other vegetables).
A_2	Cash and Feed Grains, Oilseeds.
	Improved Pasture and Forage Crops.
P_1	Hay, Alfalfa, and Permanent Pasture.
P_2	Forage Crops (excluding hay, alfalfa and feed grains but including corn for ensilage and "beets").
	Unimproved Pasture and Range Land
K_1	Unimproved Pasture
K_2	Open Range
K_3	Hay and Alpine Meadows
K_4	Poorly Vegetated Land (up to 75% rock or sand)
--K	Forest Range (This applies to areas which are on, or contiguous with, occupied farmland or if there is evidence or knowledge of grazing activity).
	WOODLAND
	Productive Forest Land
T_1	Mature Forest. Land bearing a productive forest type with at least one tree per acre greater than 11.1" d.b.h.
T_2	Immature Forest. Productive forest land with immature cover.
T_3	Recently Logged or Burnt. Forest land which has been logged, burnt, or diseased and has not been satisfactorily restocked.
	Non-Productive Woodland
U_1	Alpine Forest
U_2	Shrubland (including treed muskeg)
	OTHER
M	Swamp, Marsh, and Bog. Open wetlands except for those with evidence or knowledge of haying or grazing in the drier years.
	Unproductive Land. Land that is biologically unproductive in its present state.
S	Sandflats, Dunes and Beaches. Depositional features with exposed sand surfaces predominating.
R	Rock and Other Unvegetated Surfaces. Erosional features including badlands, eroded river banks, etc.
X	Water Surfaces. Excluding temporarily flooded hay meadows, etc. All uses in areas of permanent water are shown with dashed boundaries and bracketed symbols, e.g. Marine park (O).

interviews were informal exchanges which occurred whenever the situation presented itself, but the information volunteered by co-operative locals aided significantly in the assessment of land use and disuse." (Agr. Can., Soil Res. Inst., 1975).

A two-man team was able to conduct such interviews and other aspects of the survey at an average mapping rate of 1,500 acres per day.

The pattern for land tenure for the study area was determined using Provincial Tax Assessment Office maps displaying property lines and code numbers for each land parcel. Then these were used to extract pertinent information from Municipal Tax Rolls. This specific data was generalized and mapped in categories such as Developer Owned, Government Owned, Domestically Owned, and Institutionally Owned. Land tenure patterns were then correlated with the land use map to determine the extent to which the two features were related.

TABLE B 6.1. COMPARISON OF WORLD, CANADIAN, AND SOIL RESEARCH INSTITUTE LAND USE CLASSIFICATION LEGENDS

WORLD	CANADIAN	SRI
Settlements & associated non-agricultural lands	Urban: 1) Industrial 2) Commercial 3) Residential 4) Recreational 5) Associated non-agricultural	Urban: 1) Residential 2) Commercial 3) Extraction 4) Manufacturing 5) Municipal Government 6) Institutional 7) Utilities 8) Recreation
Horticulture Tree & other perennial crops	Tree Fruits & Horticulture: 1) Horticulture 2) Vineyards 3) Orchards 4) Other (blueberries, etc.)	Agricultural: 1) Orchards 2) Market Gardens 3) Sod Farms 4) Garden plots
Cropland: 1) Continual and rotation cropping	Cropland: 1) Hay 2) Grain 3) Other (oilseeds, etc.) 4) Other (tobacco, etc.)	1) Corn 2) Small grains 3) Soybeans 4) Summer fallow 5) Hay 6) Pasture
Improved permanent pasture Unimproved grazing land: a) Used b) Not used	Pasture: 1) Improved 2) Open grassland 3) Scrub grassland	Non-agricultural: 1) Abandoned land: - 1-3 years - 2-10 years - 10 years 2) Forest 3) Reforestation
Woodlands: a) Dense b) Open c) Scrub d) Swamp forests e) Cut-over or burnt over f) Forest with subsidiary cultivation	Woodlands: a) Dense b) Open c) Scrub d) Cut-over or burnt over	
Swamps and marshes (fresh and salt-water, non-forested)	Water: 1) Water 2) Swamps and marshes	Water: Swamp, marsh or bog
Unproductive	Unproductive	

TABLE B.6.2. OTTAWA URBAN FRINGE AREA LAND USE CLASSIFICATION SYSTEM

CODE	LAND USE	DESCRIPTION
	URBAN USES	
R	Residential	dwelling places and directly associated land (lawns, gardens, laneways, etc.)
		In the case of farms; include barns, out-buildings, and yards with the residence.
Cm	Commercial	businesses offering goods and services directly to the Public (service stations, motels, etc.)
		Small commercial establishments within a larger residential area are not distinguished.
E	Extraction	sand and gravel pits and quarries
ETS	Extraction	topsoil removal
		Include areas where topsoil is stockpiled in windrows.
M	Manufacturing	primary production of industrial goods (asphalt, tile, cement plants, etc.)
		Large complexes which process raw materials for industrial use. They are usually associated with sand or gravel quarries.
D	Municipal government usage	vehicle garage, dump, etc.
		Do not include areas for which use is more accurately described by any other category (e.g. Township tree nursery).
I	Institutional	schools, churches, cemeteries, etc.
T	Utilities	transportations, communications (hydro lines, transformer stations, radio towers, etc.).
		A more active use takes precedence over transmission lines (e.g. hydro lines across a grain field are disregarded).
B	Recreation	facilities open for public use (playgrounds, playing fields, etc.)
		Do not include such commercially oriented uses as the Rideau-Carleton Raceway or private campgrounds.
	AGRICULTURAL USES	
	Intensive:	
K	Orchards	public sales
		Do not include household stands of less than ten trees - these are gardens and fit the residential category.

TABLE B.6.2. (Continued)

CODE	LAND USE	DESCRIPTION
	AGRICULTURAL USES (cont'd)	
N	Market gardens	public sales Include only those vegetable gardens which represent a major investment of the operators time and money and on which he depends for a large part of his livelihood. Identifying features include: large plots of different vegetables; separate plots of the same species at different stages of maturity, often a permanent roadside stand; evidence of packaging (crates, baskets, packing shed, etc.); special machinery (planters, row cultivators, irrigation equipment, etc.); and may be associated with greenhouses, hotbeds, etc.
S	Sodfarms, nurseries, flowers	public or commercial sales
Q	Garden plots	non-owner use An area of land that the landowner has subdivided into a number of small plots, each of which is rented to an urbanite for the purpose of cultivating his own vegetable garden.
C	Corn	sweet or grain
G	Small grains	oats, barley, wheat, rapeseed, etc.
V	Soybeans	
F	Summer fallow	cultivated but unused Include here any land which is involved in a regular crop rotation scheme but which is lying idle this year. Also include land which has been abandoned for several years prior to being rebroken, but is not planted this year. Visual recognition of this class is most positive in June and July, when the fields are cultivated but show no signs of crop growth other than possibly buckwheat, which is used as a cover crop for land lying fallow. At other times of the year fallow land can be confused with this year's crops that have either not yet germinated, or have been harvested and plowed under. Usually fallow land will be roughly worked, (i.e. plowed only) during the growing seasons and hence may be grown up in weeds by late summer. However, it lacks the complete sod cover characteristic of abandoned land. In some cases it might be necessary to examine the type of stubble that has been worked into the topsoil, and by a process of elimination, determine the correct category. If it is idle land which has been reworked it is recognizable by the turned under willows, small trees, etc. Also, the fence lines and corners may indicate whether or not a crop has been grown this year.

TABLE B.6.2. (Continued)

CODE	LAND USE	DESCRIPTION
	AGRICULTURAL USES (cont'd)	
H	Hay	all fodder crops which are harvested and stored as feed. Prior to being harvested, hay fields present a smooth, even appearance due to the uniform planting and growth of non-native vegetation. They lack evidence of animal grazing (paths, rough surface, etc.) and have very few native weeds and shrubs. They usually show some signs of cultivation (rows, furrows) and low, wet areas show up as patches of stunted growth. After-harvest identification is simplified by the machine cut stubble bounded by undisturbed, tall vegetation along fence lines and drainage ditches; around obstacles in the field; and at the corners of an "around the field" cutting pattern. This uncut border is highly characteristic of the category and remains visible well into the fall, even showin through second growth legume forage. After-harvest pasturing of hay fields is quite common and may alter the appearance of the field, but the evidence of machine harvesting remains.
P	Pasture	natural grazing and improved. Include all land for which active grazing by livestock is the only use this year, regardless of the condition of the pasture. Free movement of animals makes identification easy in that they leave well worn paths through ditches and gaps in the fences, to the water source, and to shade trees. The pasture field itself is spotty and irregular, with scattered clumps of weeds and shrubs. Improved pasture has a mixture of native and cultivated vegetation and may have evidence of cultivation. Natural grazing areas are generally close cropped, with the ground surface readily visible as rough and hummocky, particularly in low areas. There are no signs of machine workings and there are often protruding stones. Abandoned hay fields now used as pasture have a mixture of close cropped native vegetation and taller timothy and brome in scattered and broken patches. Fallen trees and limbs are rarely removed from pasture fields, while shrubs and small trees are often physically damaged by the livestock. Interior fences become broken down, but the pasture is bounded by animal-proof fences.
	NON-AGRICULTURAL USES	
A	Abandoned land	land formerly used for agricultural production, but now lying idle and in a stage of reversion to natural vegetation. no evidence of active use this year
	A1	land idle for 1 to 3 years Fields are overgrown with weeds and grasses, with an understory of similar material in a state of decay. There may be minimal growth in wet areas, but no woody vegetation over 2' in height. No trees visible. Fences may still be good and drainage ditches are visible but filling in with

TABLE B.6.2. (Continued)

CODE	LAND USE	DESCRIPTION
	NON-AGRICULTURAL USES (cont'd)	
		vegetation. There may still be traces of cultivation but any vegetative difference along fences and ditches and around fallen trees has disappeared.
	A2 land idle for 2 to 10 years	
		Land similar to A1, but in a more advanced stage of vegetative succession. Weeds and grasses are dominant but there are scattered willows, alder and small poplar trees to 8 feet in height and covering up to 30% of the total area. Trees are fast growing types with a height of up to 6 or more feet. Most woody growth spreads out from the fence lines and in depressional areas, leaving central, higher areas covered with weeds. Fences generally show signs of degradation and drainage ditches are less visible. Cultivation marks are absent.
	A3 land idle for 10 or more years	
		An intermediate stage of vegetative succession between A2 and forest. Brush, shrubs, and poplar stand between 8 and 25 feet in height and cover more than 30% of the total area or slower growing trees such as cedar, elm cherry, apple, or maple appear scattered but well established. The presence of even a few of the species indicates a lengthy undisturbed condition and hence deserves A3 classification. At this point fields are beginning to lose their distinctive regularity as soil and topography exert their influence on vegetation. The plant community begins to conform to natural landform conditions, hiding fences and ditches.
Z	Forest	land covered with a continuous stand of trees over 25 feet in height.
Zr	Reforestation	land supporting a stand of artificially stocked trees.
X	Swamp, marsh, or bog	Natural depressional areas which are waterlogged for most of the year and support an overgrowth of cattails, reeds, sedges, etc. These areas have no recognizable active use and may encompass small ponds of standing water.
W	Water	areas of open water greater than 1/3 acre in size.

NOTE: CONVENTIONS

Combined symbols (i.e. P-A1) are used in cases of marginal or vacillating use. The first symbol represents the most recent active use and the second indicates the present conditions.

e.g. P-A1 denotes pasture with many of the characteristics of the A1 category. E-A1 denotes a gravel or sand pit which has not been used in the last 1-3 years.

B.7: LAND CAPABILITY AND DEVELOPMENT CONSTRAINTS MAP, MIDWESTERN ONTARIO ECONOMIC REGION

In 1969, the Special Projects Section of the Regional Development Branch, Ontario Department of Treasury and Economics reported on its Land Capability and Development Constraints Map. The main purpose of the map was to pinpoint on a regional basis some specific land capabilities and to relate these capabilities to existing land use. The map also was to provide a means of evaluating the land capability and physical development constraints associated with the expansion requirements of selected urban centres. While the technique developed had specific application to the Midwest Ontario Economic Region, it was considered to have relevance to the province as a whole.

The Land Capability and Development Constraints Map (scale 1:25,000) is a composite of a generalized regional land use map and overlay maps detailing land capability and development constraints. Two types of land use maps were to be produced for each economic region: 1) work maps at the scale of 1:50,000; and 2) generalized regional maps at the scale of 1:250,000.

With respect to the work maps the Canada Land Inventory (CLI) Present Land Use maps were to be used as base maps upon which additional land use information would be plotted. The categories of the CLI land use classification (B.1) were grouped for presentation purposes.

1. "In southern Ontario where agriculture is the dominant land use, productive and non-productive woodland were grouped together into a single land use class. Land classed as being in some form of agricultural production was left uncoloured.

2. "In northern Ontario where forestry is the dominant use, horticulture, orchard and vineyards and cropland uses were combined on the one hand, and improved pasture and forage crops and rough grazing and rangeland on the other. The two new land use categories were coloured as separate land use classes. Land classified as being in some form of forestry production remained uncoloured." (Ont., Dep. of Treas. and Econ., 1969).

Land use maps prepared by the Special Research Section, Community Planning Branch of the Department of Municipal Affairs were to constitute an important source of urban land use information. Residential, seasonal residential, commercial and industrial land use were to be added to CLI base maps from the Community Planning Branch maps. The classification for Branch maps is shown on Table B.7.1. Because of the range of variance in terms of scale, date, and content shown on these maps, municipal planning department urban land use information was to be used whenever it seemed more suitable than that of the Branch.

The generalized regional land use maps (1:250,000) were prepared from the detailed CLI maps (i.e., 1:50,000). The land use classification used in the generalized maps are shown on Table B.7.2. The residential category includes, in addition to all types of dwelling units, institutional land uses such as schools and churches. The forested areas are a combination of productive and non-productive woodland as outlined on the CLI maps. They are a minimum of 150 acres in size.

TABLE B.7.1. CLASSIFICATION FOR LAND USE MAPS ONTARIO DEPARTMENT OF MUNICIPAL AFFAIRS

CATEGORY	LAND USE
1.	Residential
2.	Residential vacant or under construction
3.	High-density Residential (R4 and over)
4.	Summer Residence
5.	Farm
6.	Farm vacant or under construction
7.	Commercial
8.	Industrial
9.	Primary
10.	Other
11.	Recreation Resorts

NOTE: The actual content of the legend shows a slight variation from one section of the Province to another.

TABLE B.7.2. GENERALIZED LAND USE MAPPING ONTARIO ECONOMIC REGIONS

CATEGORY	PRISMA COLOUR No.[1]
Residential	915
Seasonal Residential	939
Industrial and Commercial	932
Quarries, Sand and Gravel Pits	934
Outdoor Recreation	913
Forestry	909
Agriculture	911
Indian Reserve	963
Airport	963 & 935
Railway	935
Major Roads	935
Water Bodies	309

B.8: CHANGE IN LAND USE ON EITHER SIDE OF THE QUÉBEC--VERMONT BORDER

In 1976, R.N. Drummond of the Department of Geography, McGill University reported on a land use study in a 16- by 90-mile area on either side of the Canada-United States border in Québec and Vermont respectively. Drummond stated that:

> "The overall objective of the original project was to examine the nature, extent and location of changes in land use on either side of the Québec-Vermont border. It included the mapping of these changes and their correlation with physical parameters and with social and economic factors in an attempt to explain variations in land use changes in different sectors of the border area. A second and parallel major objective was to develop a methodology that would facilitate the comparison of regions that are spatially juxtaposed but which are different as to dates, scales, classifications, etc., of source material. The broad goals were sought through more specific objectives in two main phases - first, to develop, test and apply a methodology for the collection and analysis of the data, and secondly to analyze and interpret the information (in conjunction with other researchers) with particular emphasis in the socio-economic aspects of the border area." (Drummond, 1976).

Only the first phase of the study, that concerned with the development of methodologies and classifications is treated here.

The land use classification (Table B.8.1) was derived from two sources, the Vermont Land Capability Plans compiled by A. Lind (Vermont State Plan. Office, 1972) and P. Clibbon's work on the Canada Land Inventory in Québec (see B.9).

Twenty-eight types of changes in land use were developed and used in the study. (Table B.8.2).

TABLE B.8.1 QUÉBEC-VERMONT BORDER PROJECT LAND USE CLASSIFICATION

VERMONT SCALE, 1:62,500 CLASSIFICATION	VERMONT SYMBOLS	QUEBEC SYMBOLS	QUÉBEC SCALE, 1:50,000 CLASSIFICATION
Pasture	Gp	P	Improved pasture
Grassland	Gw	K	Unimproved grazing land
Scrub	S	U	Scrub
Urban	Urb	B	Urban and associated non-agricultural land
	-	M	Swamps
	-	S	Unproductive land (bare rock, sand area, etc.)
Crop	C	A	Cropland such as potatoes
	-	H	Horticulture
Orchards	O	G	Orchards
	-	E	Mine quarry, peat bog, etc.
	-	O	Recreational (cottages, parks, golf, etc.)
Forest, Deciduous Forest, Mixed	Fd fm	T	Woodlands
Forest, Coniferous	fc	Z	Lakes and Rivers

1 After Vermont-Land Capability Plan 1972 (compiled from 1962 air photographs by Prof. A. Lind, University of Vermont).

2 After Canada Land Inventory and Classification, Prof. P. Clibbon, Université Laval. 1965.

TABLE B.8.2. TYPES OF MOST COMMON CHANGES IN LAND USE QUÉBEC-VERMONT

TYPE	MEANING FROM	MEANING TO	NUMBER FOR PROGRAMS
T → U	forest	scrub	1
T K	forest	unimproved pasture	2
T P	forest	pastures and cropland	3
T B	forest	urban	4
T O	forest	recreation	5
T G	forest	orchard	6
T S	forest	unproductive land	7
P T	pasture	forest	8
P U	pasture	scrub	9
P K	pasture	unimproved pasture	10
P B	pasture	urban	11
P O	pasture	recreation	12
P G	pasture	orchard	13
P S	pasture	unproductive land	14
U T	scrub	forest	15
U P	scrub	pasture	16
U K	scrub	unimproved pasture	17
U B	scrub	urban	18
U O	scrub	recreation	19
U G	scrub	orchard	20
U S	scrub	unproductive land	21
K T	unimproved pasture	forest	22
K P	unimproved pasture	pasture	23
K U	unimproved pasture	scrub	24
K B	unimproved pasture	urban	25
K O	unimproved pasture	recreation	26
K G	unimproved pasture	orchard	27
K S	unimproved pasture	unproductive land	28

NOTE: These are not the only possible changes, but they represent the most common ones (99%), to which we gave a numerical value for the sake of computer analysis.

These classifications depend on the identification of land uses and of changes from aerial photographs. The resulting maps, therefore, are based upon and limited by air-photo interpretation supplemented by field checking and observation.

Detailed information on the classification is available in three reports (Drummond, 1975 and 1976; Drummond et al., 1975). The author reported that the achievement of several basic objectives of classification and methods of air-photo interpretation and computer handling of data and their application in various ways (field work, lab work, library work) has provided a range of information on the border region. This includes:

1. original manuscript maps on acetate at size and scale of photo mosaics, namely:

   a) land use 1961 Québec
      1962 Vermont

   b) land use changes
      1961-71 Québec
      1962-71 Vermont
      1945-61 Québec
      1945-62 Vermont

   c) soil type in eight categories and slope in four categories (Québec)

2. computer cards containing the above data, stored by map sheet area;
3. computer print-out by map sheet of above data;
4. computer plotted maps;
5. compilations from census reports;
6. field interview;
7. library collection; and
8. student research and map projects in the area.

B.9: MIRABEL STUDY (EZAIM) LAND USE CLASSIFICATION

Structure and Dynamics of Land Use by Clibbon et al. (1975) is one of ten volumes prepared by the EZAIM research group (Ecologie de la Zone de l'Aéroport International de Montréal) during the 1970's. The purpose of this report is "to describe and to attempt to explain the recent evaluation and present patterns of land use within the territory expropriated for the construction of the new Montréal International Airport at Mirabel, Québec, Canada". The study as a whole consisted of a detailed investigation of the environment of the Mirabel area. The research was commissioned by the National Research Council of Canada and the EZAIM group which undertook the work was affiliated with the Centre de Recherches Ecologiques de Montréal (CREM) in 1971 and 1972.

The EZAIM group enquired into the condition of both the biophysical and human environments. The report

> "deals with what might be loosely termed the "human geography" of Mirabel. It relates particularly to man's relationship with the land, and can therefore be termed a "land-use" study. It takes the form of a detailed investigation of the land-use patterns at Mirabel as they existed in the summer of 1971. Because the zone is predominantly rural, the emphasis is on forming [farming] and on associated activities such as the exploitation of farm woodlots. However, urban and recreational land uses are also studied in detail even though they are poorly represented in the territory. Cultural features such as farm buildings, drainage ditches, and fences have also been inventoried and mapped, and inequalities and inconsistencies in their distribution patterns are described and explained." (Clibbon et al., 1975).

By 1971, the Mirabel study area already had been profoundly influenced by events surrounding the construction of the new airport. Almost 100,000 acres of farmland and forest had been set aside for development through expropriation, construction of runways was underway, dispossessed farmers were leaving the area, and abandoned buildings and derelict farmland contributed to a rapidly changing land use scene. A precise measure of the impact which the construction of the airport had upon the local landscape was possible, however, because the Canada Land Inventory (CLI) undertook a detailed investigation of land use patterns in southern Québec between 1965 and 1968. The Mirabel area was field-mapped in 1966 and the land use data recorded on aerial photographs at a scale of 1:15,840. The classification was that of the CLI with some modifications to allow for special Québec problems (Clibbon, 1967). The classification, in turn, was based on the more elaborate system employed in the Canadian Land Use Classification (A.3) which had been inspired by the World Land Use Survey (A.1).

The availability of detailed land use maps for the pre- and post-expropriation periods (i.e., 1966 and 1971) enabled the EZAIM group to evaluate the nature and significance of expropriation on the Mirabel area. The specific areas occupied by different types of land use in the two years were measured and the data analyzed and compared. The maps were then superimposed and areas which had been subjected to land use change during the five-year period were identified, measured, and then plotted on a separate series of maps.

The 1971 land use field-survey data was plotted on 1:6,000 vertical aerial photographs and then transferred to a 1:20,000 hand-coloured base map. The classification was then generalized and a 1:20,000 black-and-white edition was printed. Data which could not be included on this map because of technical limitations have been presented on a special se. ies of six maps.

The classification adopted for the preparation of the 1971 land use map, states:

> "In probably one of the most complex and detailed ever used for a rural land-use survey in Canada ... (T) here are five general land-use classes: urban and para-urban land use; cultivated land; abandoned farmland; forest; and 'others'. Within these classes there are numerous land-use 'categories', and many of these have been further subdivided. For example, the 'cultivated land' class includes the 'pasture' category, which in turn comprises four subcategories: improved permanent pasture, rotational pasture, unimproved pasture, and feedlots.' (Clibbon et al., 1975).

Their land use classification is shown as Table B.9.1 providing detailed definitions of the three-level classification employed by the EZAIM research group.

TABLE B.9.1. EZAIM LAND USE CLASSIFICATION FOR FIELD MAPPING OF THE MIRABEL AREA IN 1971

CATEGORY	LAND USE	MANUSCRIPT MAP SYMBOL
I.	URBAN AND PARA-URBAN LAND USE	
	i) Industrial areas	X
	Rock quarry	Xc (Xc-A if abandoned)
	Sand pit	Xs (Xs-A if abandoned)
	Gravel pit	Xg (Xg-A if abandoned)
	ii) Commercial areas	2
	Hotel	2h
	Motel	2m
	Auto parts yard	2c
	iii) Residential areas	3
	iv) Recreational areas	4
	Cottage	4a
	Summer camp	4b
	Golf course or driving range	4c
	Rifle range	4d
	Campground	4ec
	Picnic ground	4ep
	Improved beach	4f
	Playground	4g
	Skating rink	4h
	Racetrack	4j
	Tennis court	4k
	Trail for horseback riding	4l
	"Go-Kart" track	4m
	v) Institutional areas	5
	Garbage dumps	5a
	Cemeteries	5b
	Schools	5c
	Churches	5d
	vi) Land being used for the construction of landing strips and other airport facilities, including access roads	Tr
	vii) Power transmission line	
II.	CULTIVATED LAND	
	i) Hay	H
	Good-quality hay	H1
	Poor-quality hay	H2
	Alfalfa	HL
	(pastured: HLp; ploughed under: HL1)	

TABLE B.9.1. (Continued)

CATEGORY	LAND USE	MANUSCRIPT MAP SYMBOL
II.	CULTIVATED LAND (cont'd)	
	ii) Pasture	P
	Improved permanent pasture	Pa
	Rotational pasture	Pb
	Unimproved permanent pasture	Pc
	Feedlots	Pe
	iii) Grain	B
	Wheat	B1
	Oats	B2
	for fodder	B2f
	pastured	B2p
	for silage	B2e
	ploughed under	B21
	Barley	B3
	Rye	B4
	Buckwheat	B5
	Mixed grain (mixtures not specified)	B7
	Grain corn	B6
	for consumption of humans	B6c
	for consumption by livestock	B6m
	for seed	B6s
	for sale to distilleries	B6d
	Silage corn	B6e
	Corn for green fodder	B6f
	iv) Market gardening	C
	Vegetables (including small plots of potatoes and sweet corn)	C1
	Nurseries	C2
	Floriculture	C4
	Greenhouses	C5
	Bulbs	C6
	Soya beans	C9
	v) Potatoes (large areas only)	A
	vi) Small fruits	F
	Strawberries	F1
	Raspberries	F2
	vii) Orchards	G
	Apple	G1 (G1-A if abandoned)
	Plum	G5 (G5-A if abandoned)
	pastured: p	
	viii) Sod farms	Pe1
	ix) Fallow land	J
	x) Barnyards and farmyards with buildings demolished	Z (Z-D)

TABLE B.9.1. (Continued)

CATEGORY	LAND USE	MANUSCRIPT MAP SYMBOL
III.	ABANDONED FARMLAND	
	i) Recently abandoned farmland ("weedy grassland")	K
	ii) Scrubland	U
	pastured (rough grazing)	Kp, Up
	cutting of firewood	Kc, Uc
	intensive hunting of small game	Kf, Uf
IV.	FOREST	
	i) Unused (or occasional cutting of wood for use on the farm)	6
	Burned over	6d
	ii) Utilized	7
	Tapping of sugar maples for commercial purposes	7e
	Intensive hunting of small game	7f
	Pasturing of livestock	7p
	Clear-cutting	7b
	Selective logging	7s
	(For 7b and 7s, the timber cut is used for pulpwood (b), for sawmilling (s), or for firewood and general use on the farm (c). Example: a stand of spruce being clear-cut for pulpwood is identified by the letters 7bb.)	
	iii) Coniferous plantations	
	New	8
	Sub-mature	9
	Mature	10
V.	OTHERS	
	Swamps and marshes	M1
	Peat bogs	M2
	Areas of bare sand, clay, and rock	Sn, AGn, Rn respectively
	Standing and running water	EAU

B.10: A REMOTE SENSING COMPATIBLE LAND USE ACTIVITY CLASSIFICATION

In 1975, Ryerson and Gierman reported that agencies of various levels of government in Canada had identified the need for a standardized present land use classification system which would be compatible with the existing Canada Land Inventory (CLI) Land Use Classification (see Table B.1.1), which would make use of recently available remote-sensing imagery, and which had the capacity to provide useful, detailed information at both national and regional levels.

Two principal constraints were recognized in introducing the classification system. First, the system preferably should be related to the CLI system (B.1) and the Canadian Geographic Information Sytem (CGIS), maintained by the Lands Directorate, Environment Canada (1973, and 1977a and b). Were the new system not made compatible with the CLI, it would not be possible to delineate land use change and to employ the existing data base for national projections in southern Canada. Ideally, therefore, the new classification should be applied to the collection of similar classes of data at the scales employed in the CLI -- 1:50,000 and 1:250,000.

Secondly, although most land use data can be less expensively obtained through remote sensing, this method cannot always provide the exact information required. The authors observed that:

> "The implication is that the land use categories should be derived from the land cover imaged by the remote sensor. In the extreme, this could result in classes which are dictated by the remote sensor's sensitivity and by the scale of data, rather than by the user's data needs. Only minimal concessions should be made to the sensor; the user's data needs must prevail in an operational system, but the user should be made aware of the additional land cover discriminatary capabilities of remote sensors." (Ryerson and Gierman, 1974).

Six guiding principles are recognized in the classification formulation process:

1. "The existing concepts and conventions relating to land use and its classification should be followed as closely as possible.

2. "The system should be compatible with Canada's existing satellite and high altitude airborne imagery for which operational or near operational analysis systems exist. This suggests the use of satellite data with a resolution cell of one-half hectare and 1:100,000 to 1:135,000 scale colour or colour-infrared airborne imagery.

3. "Land use mapping can be done at many levels of detail. The data sources indicate that at least two levels of detail should be designed into the classification.

4. "All classes which are developed should be designed so as to relate to the classes of the CLI land use classification.

5. "The classes sought should be similar to those which are required by the present and potential Canadian users of land use information.

6. "The classification should not be presented as a fully operational universal system from which a user must not deviate. This work should be regarded as a preliminary focus for criticism which will, with the help of colleagues, evolve into a land use classification which will be useful throughout the country."

A two-level classification has been developed using four key elements: the concepts of classification; user needs; remote-sensing imagery; and the existing

CLI Land Use Classification. The first element, concepts of classification, is discussed in detail by Ryerson and Gierman. (Table B.10.1).

Level I classes were found to be readily available from most ERTS imagery by scientists at the Canada Centre for Remote Sensing (CCRS). This classification is distinct, however, from the USGS system (C.1) which assumes that the information is available using imagery from all times of the year.

The Level I classification has been successfully applied using both digital techniques and visual interpretations of ERTS imagery.

The Level II classification possess similarities to land use mapping undertaken by the CCRS and the Lands Directorate for the Great Lakes Pollution from Land Use Activities Reference Group, International Joint Commission (Ryerson and Gierman, 1974). The authors suggested that the classification be applied only by those with some local knowledge of the region being mapped. Lower quality imagery, or imagery from different times of the year, may suffice if larger scales are used.

The system is considered to be preliminary and subject to modification and improvement.

B.11: PRINCE EDWARD ISLAND LAND CAPABILITY AND LAND USE CLASSIFICATION FOR APPRAISAL PURPOSES

The Prince Edward Island Assessment Act states that all real property must be assessed at market value. To facilitate the appraisal process the Land Valuation and Assessment Division of the province's Department of Finance prepared an Appraisal Manual which states:

> "The appraisal of real property for assessment involves an identification of each property by type, class, grade and the application of appropriate Unit Value with proper allowance for depreciation; obsolescence; utility; location and economic obsolescence." (PEI, Dep. Finance, 1977)

The Province of Prince Edward Island has a comprehensive Land Capability Classification. The system is based on orthophoto land ownership maps on a scale of 1 to 5,000. The classification generally follows the Canada Land Inventory (CLI) sytem, but it has been somewhat simplified so that it may be readily applied by a property appraiser/assessor who is not a trained soil specialist.

Each individual property in the province is numbered in sequence and the data is computerized. Each property is identified in the Land Titles Office and Assessment and Taxation Rolls by a twelve digit property number. The first three digits of this number are reserved for future use. The next five digits are being used consecutively, starting at 00001 and eventually reaching 99900. The sixth digit is a check digit and the final three digits are used to identify properties subject to leases, easements, or restrictive covenants. The latter are used where one property is subject to two or more tax assessments and tax bills. The Manual states that these three digits have been assigned arbitrarily to simplify data processing and provides an example. Lease Code Numbers 101-199 are used:

TABLE B.10.1 LAND USE ACTIVITY CLASSIFICATION LEVELS

LEVEL I*	CLI LAND USE CLASSES**	LEVEL II***
Water	2	
Urban	B O	Low density residential[5] (single family, duplex and rooming houses)
		Medium-density residential (row housing condonminiums, low rise apartments)
		High density residential[6] (high rise apartments)
		Commercial[7] (retail, strip development, shopping centres)
		Industrial (large factories, oil storage and associated land)
		Commercial and Industrial[8] warehousing, areas of mixed uses, small factories)
		Transportation and Utilities (rail yards, 4-lane highways, interchanges, harbour facilities and power installations)
		Open space and recreation[9] (parks, golf courses, ski hills, large playing fields, cemeteries, other open land)
Improved Agriculture[1],[10]	A P H	Cropped land (grain, corn and other field groups)
		Improved pasture and hay
		Horticulture (vegetable crops, market gardening)
		Farmsteads and agricultural buildings (barns and other buildings associated with farm or agricultural use)
Rangeland and Rough Pastureland[11]	K	
Forest and Mature Orchards[2]	U T G	Coniferous
		Deciduous and mature orchards[12]
		Mixed
Wetlands[3],[11]	M	
Barren and Extractive[4]	S L E	Sand, gravel and other open pit extractive
		Sand
		Slag and tailing piles (associated with mining and basic refining)
		Exposed bedrock

* For use with satellite imagery. Suggested mapping scale of 1:250,000
** Used originally with low- to medium-altitude airborne imagery
***For use with high-altitude airborne imagery 1:100,000 and mapping scale of 1:50,000. Unless complexing or point symbols are used, the smallest area that can be mapped is 4.5 hectares, thereby removing most single buildings.

Level I notes:

[1] A and H may be differentiated from P where spring or early fall digital satellite data are used for agricultural fields which are larger than two to four hectares. "O" may fall into this class in some cases.

[2] These two classes are grouped because of difficulty in separating them when using satellite data. In some cases the "U" category of the CLI may be called "K".

[3] Wetlands will be determined by the earth's surface reflectance. Some wetlands may not be distinguishable because of the vegetation canopy; other types may be separable, and for intermittent wetlands, season of imagery may be critical.

[4] Automated techniques that differentiate objects by using only their reflectance (not their geographic position) usually cannot distinguish between barren land and extractive uses. Manual interpretation may carry this separation to the full CLI categories. In some cases, urban and barren may appear similar. Local knowledge would then be useful.

Level II notes:

[5] Some residences may be missed in complex areas. Commercial encroachment may not be recognized in areas of larger homes near central business districts. Most rural, non-farm residences can be identified. Churches and schools in residential areas may fall in this or the following class.

[6] In the urban core there may be confusion between this category and other high rise structures used for hotels and office buildings.

[7] This category may include some residences and walk-up flats. Churches and some schools would often fall into this class.

[8] Complex areas and those which are not positively identified as belonging to another class would be placed here.

[9] Large outdoor recreation facilities, schoolyards, cemeteries, and parks may be identified separately.

[10] Spring or late-summer imagery is required.

[11] Subclasses have not yet been determined.

[12] Orchards and vineyards cannot be positively identified at this scale, colour-infrared imagery at a scale of 1:60,000 has been proven useful for this purpose.

When there is an unregistered deed to a parcel of property and where there is a building or structured erected on a parcel of land and owned by a person other than the landowner, such as a fisherman's shed on government property, a second or subsequent similar property would be coded 101, 102, etc.

When part of a property is exempt from taxation (or subject to special tax agree ment) the property number would be assigned to the taxable portion. A lease code number (the 151 series is being used) is applied to the exempt portion, this will avoid duplication of numbering and tax bills. In such cases, the market value assessment will be divided between the taxable portion and the exempt portion. Lease Code Number 201 and up are used where all or part of a property is subject to a registered lease, and the lessee pays the taxes such as CNR or government properties. Other code numbers can be used as necessary.

Property area is recorded to three places of decimals. This arrangement ensures that even the smallest of building lots is outlined. Data on property is kept up-to-date on a weekly basis.

A unit of real property is defined as "a portion having comparable physical and functional characteristics or highest and best use". Each unit is identified by a five-digit number which states its type, class, and grade. The classification of property by type and class involves the use of an arbitrary numbering system. As to the grading system:

> "(it) reflects an estimate of the degree of physical limitation in use by analy sis of applicable criteria. This is a quantitative and qualitative analysis which is reflected in the grade and the unit values to be applied."

Each type and class of property is considered in detail in the Manual and a range of criteria for grading are suggested.

The five-digit system in use for units of real property is broken down as follows:

TYPE — The first digit will indicate the basic type of property, an example of which is shown in Table B.11.1.

1. Land (including roads, water, and sewer system)
2. Residential Buildings and Accessory Structures
3. Farm Buildings and Property
4. Commercial Buildings
5. Recreational Property Improvements
6. Industrial Improvements
7. Institutional Improvements
8. Miscellaneous Structures
9. Leasehold Interests, Easements, Rights-of-way

CLASS — The second and third digit indicate the class of each unit of property, depending on physical characteristics, supply and demand and highest and best use (see Table B.11.1). Classes can range from 01 to 99 in each type of property.

GRADE — The fourth and fifth digits indicate the grade or capability rating of the unit. A schedule of criteria has been compiled for each class and the capability or grade will depend upon the relationship between the physical inventory and the relevant criteria. An example of classification and grading of Type 1, Class 25 land is shown in Table B.11.2.

An example of a code number for a unit of property utilizing the type, class, and grade approach might be 1-12-90. This would refer to a unit of good arable land with 90% capability.

The procedure for appraisal, based on the foregoing information, consists of six steps:

(a) Inspect property, make a detailed inventory, determine unit types involved. For example, arable land, woodland, house, and barns will be treated as at least four unit types of property and classified and graded accordingly.

(b) Make a comparison analysis between the inventory of the property and

the criteria for the classes of property being considered.

(c) Decide on the class and grade of each unit.

(d) Calculate the size and area of each unit.

(e) Delineate this data on a sketch or orthophoto map. For example: 12 ac. 1-12-90. A house could be coded 1060 sq ft 2-01-42 when 2 is a residential building, 01 is a single storey dwelling, and 42 is 5% better than a standard home.

(f) Applied Unit Costs are obtained from a Cost Manual.

It is understood that, although the information on units of property is contained on assessment status sheets, only the total assessed value of property will be made public. Other component pieces of information, even those readily available from other sources (e.g., whether or not there is a mortgage registered against the property) will not be released. This may pose problems in the compilation of PEI's Present Land Use Map (see C.4).

TABLE B.11.1. PRINCE EDWARD ISLAND REAL PROPERTY CLASSIFICATION SYSTEM, AN EXAMPLE: TYPE 1 - LAND

CLASS	DESCRIPTION	CLASS	DESCRIPTION
01	Serviced sites. Utility services or septic tank, well and pump. Graded, no residence.	31	Wildlife land - all purposes
02	Serviced residential site or septic tank, well and pump, graded, seeded, paved driveway, walks, garage. Residence on site.	32	Wildlife land - wetland
03	Approved subdivision land	33	Wildlife land - upland
04	Partially serviced subdivision site	34	Waste land - residual
05	Mobile home park	35	Tobacco land
06	Commercial site - vacant	36	Blueberry land
07	Commercial site - improved	37	Strawberry land
08	Industrial site	38	
09	Institutional site - lighthouse	39	
10	Community hall site	40	Golf courses
11	Class 1 Arable land	41	Amusement parks
12	Class 2 Arable land	42	Publicly owned parks
13	Class 3 Arable land	43	Historical sites
14	Class 4 Arable land	44	Museum sites
15	Rough pasture	45	Access roads and parking space
16	Class 1 Forestry	46	
17	Class 2 Forestry	47	
18	Class 3 Forestry	48	
19	Farm Homesite 1 acre	49	
20	Small Holders Homesite 1 acre	50	Summer motel site
21	Class 2 Ocean Frontage	51	Camping site
22	Class 3 Salt Water Frontage	52	Recreational trailer park
23	Class 4 Fresh Water Frontage	53	Summer cabin site
24	Class 1 Beach Publicly owned	54	Summer cottage site
25	Beach back-up land	55	Summer home site
26	Water lots and wharf site	56	Summer cottage approved subdivision
27	Sand dunes, ponds, unstable soil	57	
28	Speculative land - urban	58	Winter recreational site
29	Speculative land - recreational	59	
30	Speculative land - residual	60	

TABLE B.11.2. PRINCE EDWARD ISLAND CRITERIA FOR CLASSIFICATION AND GRADING OF TYPE 1, CLASS 25 PROPERTY: BEACH BACK-UP LAND

Land Back of Beach Frontage Property is an area of upland classes known as Back-Up Land. This land with a recreational value in its proximity to a beach. The area or depth of back-up land is in direct relationship to the class and grade of the beach.

Back-up land does not necessarily have direct and unrestricted access to the beach, common ownership with the Beach Frontage Property, or riparian rights where ownership is not vested in the owner of the beach frontage.

It will have the capability and value in relation to the grade and extent of the nearby beaches.

CLI Class	Capability Percentage	Lateral Extent of Beach	Depth of Back-Up Area
1	81 - 100%	80% of 1,500	2,000'
2	61 - 80%	60% of 500	1,000'
3	41 - 60%	50% of 400	400'
4	20 - 40%		Nil

The Criteria for Classification and Grading of Back-Up Land

Access to Back-Up Area

Access to beach: not to exceed 2,000'

Class and grade of beach

Suitability for Recreational Lodging Sites

(See Criteria for Recreational Lodging Sites)
(See Criteria for Public Areas)

For Public Beaches, the Back-Up Land may be situated at one end of the beach. An area within 2,000 feet would meet the requirements of a back-up area.

For more detail on various recreational criteria, see Canada Land Inventory Field Manual or Land Capability Classification for Outdoor Recreation.

LAND USE CLASSIFICATION GROUP C

C.1: A LAND USE AND LAND COVER CLASSIFICATION SYSTEM FOR USE WITH REMOTE SENSOR DATA UNITED STATES GEOLOGICAL SURVEY (primary system)

The land use and land cover classification system reviewed here has been described in detail in several publications by Anderson et. al., but the most pertinent is that published in 1976. The system is one which relies to a great extent upon recent and on-going developments in remote-sensing technology and data processing, and it is one which has had wide applicability in the United States. By October, 1977, more than one million acres or nearly 30 per cent of that country had experienced land use and land cover mapping, and completion of mapping for the entire country should be achieved late in 1982. Florida, for which mapping already has been completed, is discussed later in this section (C.2). Update or revision of land use and land cover maps was begun in 1979, with more dynamic land areas receiving priority attention. Research has been carried out to determine ways in which LANDSAT data may be used in the updating process.

The system is a product of circumstances that have become all too familiar in the classification field. Agencies at various levels of government had been collecting data about land, but in so doing they worked independently and usually without co-ordination. As federal, state, and local governments in the United States have worked towards reasonably effective, if not perfect, standardization in soil survey programs, topographic mapping, collection of weather information, and forest resource inventories, the duplication and inconsistency of effort in land classification has become increasingly apparent. Moreover:

> "Major problems are present in the application land interpretation of the existing data. These include changes in definitions of categories and data-collection methods by source agencies, incomplete data coverage, varying data age, and employment of incompatible classification systems. In addition, it is nearly impossible to aggregate the available data because of the different classification systems used." (Anderson et al., 1976).

Anderson et al. continued that the demand for standardized land use and land cover data would increase as institutions, agencies, and the public alike endeavour to assess and manage areas of critical concern for environmental control (e.g., flood plains, wetlands, energy resource development and production areas, wildlife habitat, recreational lands) and areas such as major residential and industrial development sites. The patterns of resource use and demand are constantly changing and cumulatively these changes may produce somewhat startling figures. For example, during the decade of the 1960's in the United States, 730,000 acres (296,000 ha) were urbanized each year, transportation land uses consumed an additional 130,000 acres (53,000 ha) per year, and recreational areas expanded about one million acres (409,000 ha). With the development of remote-sensing and data-processing technology, a workable and widely acceptable classification system which would be reasonably compatible with existing classification systems and which might be updated relatively easily seemed to be a real possibility.

Land use classification systems have been developed in the past. The suggestion to simply adapt one of the existing, more-or-less accepted, classifications was frequently offered, but that was not an easy or satisfactory solution to the problem. Most classifications of the past are based on knowledge that is not available from remote sensors. Also, many are patterned after biological classification systems, where fragmentation into suborders and classes is the basic technique used to accommodate information. In land use classification, a more-usual step is to aggregate groups into larger categories rather than rely on continual subdivision.

In 1971, an Interagency Steering Committee on Land Use Information and Classification was established. It had as an objective the development of a national classification system capable of using conventional sources (high-altitude aircraft) and satellite platforms. The classification would serve as a framework into which the categories of more detailed land use studies by state, regional, or local agencies could be fitted and aggregated upward from Level IV to Level I for generalized smaller-scale use at the national level. The classification also was to serve as the basis for the preparation and rapid updating of national and regional inventories which could provide an overview of land use changes, trends, and potential environmental impact of policy decisions (Hardy and Anderson, 1973).

The need for compatibility with the more-generalized levels of land use and land cover categorization in systems currently in use was recognized, especially those contained in the following: Standard Land Use Coding Manual (U.S., Dep. Transportation, 1969); The inventory of Major Uses of Land in the United States conducted every five years (Frey, 1973); and National Inventory of Soil and Water Conservation Needs, 1956, 1966 (U.S., Dept. Agric., Conservation Needs..., 1971)

Classification work by others was incorporated, notably New York State's Land Use and Natural Resources (LUNR) program (1969). The initial product was released by Anderson et al. in 1971. The revised document, (Anderson et. al, 1976) again incorporated the work of others for example, Pettinger and Poulton (1970) and the World Land Use Survey (Van Valkenburg, 1950), Shaw and Fredine (1956), and Wooten and Anderson (1957). It concentrated mainly on the generalized first and second levels of categorization.

With regard to the continuing difficulty of presenting land cover and/or land use, the system's authors find merit in the definitions presented by Burley (1961) and Clawson and Stewart (1965). The former describes land cover as "the vegetational and artificial constructions covering the land surface", while the latter determine land use to be "man's activities on land which are directly related to the land". The authors state that the types of land use and land cover categorization developed in the USGS report may be related to systems for classifying land capability, vulnerability to certain management practices, and potential for any particular activity or land value, whether intrinsic or speculative.

> "Concepts concerning land cover and land use activity are closely related and in many cases have been used

interchangeably. The purposes for which lands are being used commonly have associated types of cover, whether they be forest, agricultural, residential, or industrial. Remote sensing image-forming devices do not record activity directly. The remote sensor acquires a response which is based on many characteristics of the land surface, including natural or artificial cover. The interpreter uses patterns, tones, textures, shapes, and site associations to derive information about land use activities from what is basically information about land cover.

"Some activities of man, however, cannot be directly related to the type of land cover. Extensive recreational activities covering large tracts of land are not particularly amenable to interpretation from remote sensor data. For example, hunting is a very common and pervasive recreational use of land, but hunting usually occurs on land that would be classified as some type of forest, range, or agricultural land either during ground survey or image interpretation. Consequently, supplemental information such as land ownership maps also is necessary to determine the use of lands such as parks, game refuges, or water conservation districts, which may have land coincident with administrative boundaries not usually discernable by inventory using remote sensor data. For these reasons, types of land use and land cover identifiable primarily from remote sensor data are used as the basis for organizing this classification system. Agencies requiring more detailed land use information may need to employ more supplemental data...

"The problem of inventorying and classifying multiple uses occurring on a single parcel of land will not be easily solved. Multiple uses may occur simultaneously, as in the instance of agricultural land or forest land used for recreational activites such as hunting or camping. Uses may also occur alternately, such as a major reservoir profiding flood control during spring runoff and generating power during winter peak demand periods. This same reservoir may have sufficient water depth to be navigable by commercial shipping the year round and may additionally provide summer recreational opportunities. Obviously all of these activities would not be detectable on a single aerial photograph. However, interpreters have occasionally related flood-control activities to draw-down easements around reservoirs detectable on imagery acquired during winter low- water levels. Similarly, major locks at water-control structures imply barge or ship traffic, and foaming tailraces indicate power generation." (Clawson and Stewart, 1965).

Other problems facing interpreters include the vertical arrangement of a number of uses above and below the surface of the ground, for example, coal and other mineral deposits, subways, and underground garages.

In 1971, Anderson (1971) established ten criteria which should be met by a land use and land cover system effectively employing orbital and high-altitude remote sensor data:

1. "The minimum level of interpretation accuracy in the identification of land use and land cover categories from remote sensor data should be at least 85 per cent.

2. "The accuracy of interpretation for the several categories should be about equal.

3. "Repeatable or repetitive results should be obtainable from one interpreter to another and from one time of sensing to another.

4. "The classification system should be applicable over extensive areas.

5. "The categorization should permit vegetation and other types of land cover to be used as surrogates for activity.

6. "The classification system should be suitable for use with remote sensor data obtained at different times of the year.

7. "Effective use of subcategories that can be obtained from ground surveys or from the use of larger scale or enhanced remote sensor data should be possible.

8. "Aggregation of categories must be possible.

9. "Comparison with future land use data should be possible.

10. "Multiple uses of land should be recognized when possible."

The kind and amount of land use and land cover information which may be obtained from different sensors depend on the altitude and resolution of each sensor. For the USGS classification system the following conditions are at work, on the basis that a six-inch focal length camera is used to obtain aircraft imagery:

LEVEL	TYPICAL DATA CHARACTERISTICS
I	LANDSAT (formerly ERTS) type of data.
II	High-altitude data at 40,000 ft (12,400 m) or above (less than 1:80,000 scale)
III	Medium-altitude data taken between 10,000 and 40,000 ft (3,100 and 12,400 m) (1:20,000 to 1:80,000 scale).
IV	Low-altitude data taken below 10,000 ft (3,100 m) (more than 1:20,000 scale).

The classification categories at Levels I and II are shown in Table C.1.1 The categories are shown to be "resource-oriented" rather than "people-oriented" as demonstrated, for instance, in the U.S. Standard Land Use Coding Manual (U.S. Dep. Transportation, 1969) which itself is largely derived from the Standard Industrial Classification Manual (U.S. Bureau of the Budget, 1957). The SLUC Manual assigns seven of nine Level I categories to urban, transportation, recreational, and realted uses of land which account for less than five per cent of the U.S. The USGS system concentrates rather upon the remaining 95 per cent of the U.S. and incorporates other systems within its levels and categories where appropriate. For example, six of the Level I SLUC categories are retained under Urban or Built-up at Level II of the USGS system.

To provide a systematic, uniform approach to the display of land use and cover information in map form, at Level I the USGS system employs a modified version of the World Land Use Survey colour-coding scheme (see Table C.1.1.). At Level II and subsequent levels two-, three- and four-digit numerals would be employed. Other methods of graphically presenting land use and land cover information are briefly discussed by Anderson et al. (1976).

When maps are employed to present land use data the smallest unit area should be no less than 0.10 inch (2.54 mm) on a side. The present USGS land classification program which will cover the entire U.S. has a minimum mapping unit of 10 acres (4 ha) for Urban or Built-up Land, water areas, transitional areas in an urban situation, confined feeding operations, certain other types of agricultural land, and strip mines, quarries and gravel pits. All other categories are delineated with a minimum unit of 40 acres (16 ha).

The USGS classification system is seen by those who developed it to satisfy the three major attributes of the classification process outlined by Grigg (1975):

1. "it gives names to categories by simply using accepted terminology;
2. it enables information to be transmitted; and
3. it allows industrial generalizations to be made."

C.2: FLORIDA LAND USE AND COVER CLASSIFICATION SYSTEM

In 1976, a technical report on Florida's land use and land cover system was published. The report was the culmination of three years of work by a

TABLE C.1.1. LAND USE AND LAND COVER CLASSIFICATION SYSTEM FOR USE WITH REMOTE SENSOR DATA

LEVEL I	LAND USE CATEGORY	MUNSELL COLOUR	LEVEL II	LAND USE CATEGORY
1	Urban or Built-up Land	Red (5R 5/12)	11	Residential
			12	Commercial and Services
			13	Industrial
			14	Transportation, Communications, and Utilities
			15	Industrial and Commercial Complexes
			16	Mixed Urban or Built-up Land
2	Agricultural Land	Light Brown (5YR 7/4)	21	Cropland and Pasture
			22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticulture Areas
			23	Confined Feeding Operations
			24	Other Agricultural Land
3	Rangeland	Light Orange (10YR 9/4)	31	Herbaceous Rangeland
			32	Shrub and Brush Rangeland
			33	Mixed Rangeland
4	Forest Land	Green (10GY 8/5)	41	Deciduous Forest Land
			42	Evergreen Forest Land
			43	Mixed Forest Land
5	Water	Dark Blue (10B 7/7)	51	Streams and Canals
			52	Lakes
			53	Reservoirs
			54	Bays and Estuaries
6	Wetland	Light Blue (7.5B 8.5/3)	61	Forested Wetland
			62	Nonforested Wetland
7	Barren Land	Gray (N 8)	71	Dry Salt Flats
			72	Beaches
			73	Sandy Areas other than Beaches
			74	Bare Exposed Rock
			75	Strip Mines, Quarries, and Gravel Pits
			76	Transitional Areas
			77	Mixed Barren Land
8	Tundra	Green-Gray (10G 8.5/1.5)	81	Shrub and Brush Tundra
			82	Herbaceous Tundra
			83	Bare Ground Tundra
			84	Wet Tundra
			85	Mixed Tundra
9	Perennial Snow or Ice	White (N 10/0)	91	Perennial Snowfields
			92	Glaciers

committee representing several state agencies which was asked to prepare a land classification system.

> "The state agencies' objective was to establish a uniform land classification system that would satisfy a wide variety of users who could provide data from many sources. It was determined that the system must be compatible with classification activities at the national level, while permitting flexibility for regional and local agencies ... (I)t was agreed that the United States Geological Survey's report "A Land-Use Classification System with Remote Sensor Data" ...would be the basis for the committee's work. The U.S. Geological Survey's (USGS) system has been proposed as a national classification, thereby increasing the probability that the Florida system will be compatible with national and multi-state regional data sources." (Florida, Dep. Admin., 1976).

The committee recognized that certain classification criteria had to be adhered to in developing a multiple data-source program wherein the data ranges from that derived from orbital and high-altitude sources to that obtained from building permit records, utility records, ground surveys, and so on. Examples of classification criteria include (cf. C.1):

1. "The minimum level of interpretation accuracy in the identification of land use and land cover categories from remote sensor data should be at least 85 percent.
2. "The accuracy of interpretation for the several categories should be about equal.
3. "Repeatable or repetitive results should be obtainable from one interpreter to another and from one time of sensing to another.
4. "The classification system should be applicable over extensive areas.
5. "The categorization should permit vegetation and other types of land cover to be used as surrogates for activity.
6. "The classification system should be suitable for use with remote sensor data obtained at different times of the year.
7. "Effective use of subcategories that can be obtained from ground surveys or from the use of larger scale or enhanced remote sensor data should be possible.
8. "Aggregation of categories must be possible.
9. "Comparison with future land use data should be possible.
10. "Multiple uses of land should be recognized when possible.
11. "The system must be capable of adapting on a continuous basis to changes (i.e. improvements) in remote sensing interpretation techniques and data processing equipment and skills.
12. "The system must economically satisfy the needs of a wide variety of users." (Florida, Dep. Admin., 1976).

Florida's land use and land cover classification system is arranged in hierarchical levels whereby each successive level contains land information of increasing specificity. The classification levels are described below (Levels I to IV inclusive) and the set of numbers and land use/cover names is shown in Table C.2.1.

> "Level I - This class of data is very general in nature. It could be obtained from remote sensing satellite imagery with little or no supplemental information. Level I would normally be used for very large areas (i.e. statewide or larger), and is mapped typically at a scale of 1:1,000,000 or 1:500,000. At this scale, 1 inch equals 16 miles or 1 inch equals 8 miles respectively.
>
> "Level II - This class of data is more specific than Level I but not as detailed

as Level III. Both Levels I and II as described and defined in Section II of this report were endorsed by, and are generally used by, state agency users. Level II data is normally obtained from high altitude (40,000 to 60,000 feet) imagery, supplemented by satellite imagery and other materials such as topographic maps. Mapping might typically be at a scale of 1:126,720 or 1 inch equals two miles.

"Level III - This class of data is usually obtained from medium-altitude (flown between 10,000 and 40,000 feet) imagery supplemented from other data sources. The Level III classification is frequently used by but has not been unequivocally endorsed by state agencies. The mapping scale is typically 1:24,000 or 1 inch equals 2,000 feet.

"Level IV - This more specific class of data is obtained from low-altitude imagery (taken below 10,000 feet) and, substantially, from other supplemental sources such as windshield surveys. It is not described and discussed in the technical report. However for purposes of comparison with the above-mentioned levels, level IV might be mapped at a scale of 1 inch equalling 400 feet."

Detailed definitions and decision criteria are provided in the technical report for all categories at Levels I and II. For purposes of clarity, Level III land use/cover category are explained for Forested Uplands, Wetlands, and Water. An example of refined definition at Levels II and III is shown in Table C.2.2.

The committee has recommended that the use of colour in the graphic display of land use/cover maps should follow the USGS scheme (see Table C.1.1.).

As to the scope and use of the system, on the one hand it advantageously reduces large amounts of primary data, such as remote-sensing imagery or field-survey records, to a more comprehensible, smaller amount of secondary data, such as a land use map, and provides a useful structure of land concepts of properties. On the other hand the system does not collect or analyze information or provide conclusions; it does not include all land data; it is not sufficiently detailed to satisfy all user needs; and it only describes land use and cover at a point in time.

Because the system was designed to meet state agency needs, it will serve some but not all local government or private purposes. But, as in other systems derived from the USGS (see C.3), the Florida example is designed to permit data users considerable flexibility in modifying the classification system to meet individual needs without greatly impairing the exchange of data.

The technical report states that Levels I and II of the Florida system have been endorsed by state agency users and that it is being used on a voluntary basis by these agencies. The following are some examples:

1. "The Bureau of Coastal Zone Planning, Department of Natural Resources is using the Level II and III classifications in its Coastal Zone Planning Program.

2. "The Division of State Planning, Department of Administration, has a cost-sharing cooperative agreement with the USGS to map existing land use throughout the state, using a system very similar to the Florida Level II classification.

3. "The Department of Transportation is using a slightly revised version which adds Transportation as a Level I category and adds other subcategories as required to meet specific user needs.

4. "The Division of Technical Assistance, Department of Community Affairs is encouraging recipients of 701 Urban Planning Assistance funds to use the classification system.

5. "Several regional planning and water management agencies are using the system as a similar version in response to encouragement from federal and state coastal zone planning/management, 208 water quality planning, 701 urban planning assistance and state planning agencies." (Florida, Dep. Administration, 1976).

In its technical report, the classification committee recommended that until the system was found to be generally acceptable, every two years there should be a survey of known users to identify problems and seek solutions; and that an appropriately revised version be issued within six months of the completion of the survey.

The classification system outlined in Table C.2.3 under "A" is similar to, but does not duplicate, the Florida system. Since the USGS funded a major portion of the project and prepared most of the technical work, the system used had to reflect nation-wide needs and current technical capabilities. However, because of Florida's unique data needs, USGS agreed to develop additional information noted in "B".

TABLE C.2.1. FLORIDA LAND USE AND LAND COVER CLASSIFICATION SYSTEM

LEVEL I		LEVEL II		LEVEL III	
NO.	LAND USE/COVER	NO.	LAND USE/COVER	NO.	LAND USE/COVER
100	Urban or Built-up	110	Residential	111	Single Unit, Low Density (less than 2 DUPA*)
				112	Single Unit, Medium Density (2 up to 6 DUPA)
				113	Single Unit, High Density (6 and over DUPA)
				114	Mobile Homes, Medium Density (less than 6 DUPA)
				115	Mobile Homes, High Density (6 and over DUPA)
				116	Multiple Dwelling, Low-rise (2 stories or less) DUPA may be designated by user
				117	Multiple Dwelling, High-rise (3 stories or more) DUPA may be designated by user
				118	Mixed Residential
				119	Residential Under Construction
		120	Commercial and Services	121	Retail Sales and Services
				122	Wholesale Sales and Services, Including Trucking and Warehousing (except warehousing associated with industrial use)
				123	Offices and Professional Services
				124	Hotels and Motels
				125	Cultural and Entertainment
				126	Oil & Gas Storage Facilities (except where associated with industrial use)
				127	Mixed Commercial and Services
				128	Commercial Under Construction
		130	Industrial	131	Light Industrial
				132	Heavy Industrial
				133	Industrial Under Construction

*DUPA - Gross Dwelling Units Per Acre

NOTE: 1. At Level II, low, medium, high residential density may be designated as in Level III, based upon visual impact assessment from stereo viewing, and the resolution of the Level II imagery.

2. Numbers shown may be used for computer programming and mapping designations.

TABLE C.2.1. (Continued)

LEVEL I		LEVEL II		LEVEL III	
NO.	LAND USE/COVER	NO.	LAND USE/COVER	NO.	LAND USE/COVER
100	Urban or Build-up (cont'd)	140	Transportation	141	Airports, Including Runways, Parking Areas, Hangars, and Terminals
				142	Railroads, Including Yards and Terminals
				143	Bus and Truck Terminals
				144	Major Roads and Highways
				145	Port Facilities
				146	Navigable Waterways
				147	Auto Parking Facilities (when not directly related to another land use)
				148	Oil & Gas Long Distance Transmission Pipelines
				149	Transportation Facilities Under Construction
		150	Communications and Utilities	151	Electrical Power Facilities
				152	Major Long Distance Transmission Lines
				153	Broadcasting or Transmission Towers
				154	Water Supply Plants (Including Pumping Stations)
				155	Sewage Treatment Facilities
				156	Solid Waste Disposal Sites
				157	Other Communication Facilities
				158	Other Utility Facilities
				159	Communication and Utilities Under Construction
		160	Institutional	161	Educational Facilities, Including Colleges, Universities, High Schools, and Elementary Schools
				162	Religious Facilities, Excluding Schools
				163	Medical and Health Care Facilities
				164	Correctional Facilities
				165	Military Facilities
				166	Governmental, Administrative, and Service Facilities
				167	Cemeteries
				168	Institutional Facilities Under Construction
				169	Other
		170	Recreational	171	Swimming Beaches and Shores
				172	Golf Courses
				173	Parks, Zoos
				174	Marinas
				175	Stadiums
				176	Fairgrounds
				177	Community Recreational Facilities
				178	Racing Tracks
				179	Other Recreational
		180	Mixed--Any mixture of Urban or Built-up where no single use predominates		

TABLE C.2.1. (Continued)

LEVEL I		LEVEL II		LEVEL III	
NO.	LAND USE/COVER	NO.	LAND USE/COVER	NO.	LAND USE/COVER
100	Urban Build-up (Cont'd)	190	Open Land and Other	191	Undeveloped Land Within Urban Areas
				192	Inactive Land with Street Patterns but without Structures
				193	Land Undergoing Active Development without Indication of Intended Use
200	Agriculture	210	Cropland and Pastureland	211	Row Crops
				212	Field Crops
				213	Improved Pasture
		220	Orchards, Groves, (except Citrus) Vineyards, Nurseries & Ornamental Horticultural Areas	221	Tropical Fruit Orchards
				222	Deciduous Fruit Orchards
				223	Nurseries
				224	Ornamental Horticultural
				225	Vineyards
		230	Citrus Groves	231	Orange
				232	Grapefruit
				233	Other Citrus
		240	Confined Feeding Operations	241	Cattle
				242	Poultry
				243	Hogs
				244	Other
		250	Specialty Farms	251	Horse Farms
				252	Kennels
				253	Mariculture
				254	Other
		260	Other Agriculture	261	Inactive Agricultural Lands
				262	Other
300	Rangeland	310	Grassland		
		320	Shrub and Brushland	321	Palmetto Prairies
				322	Coastal Scrub
				323	Other Scrub and Brush
		330	Mixed Rangeland		
400	Forested Uplands	410	Coniferous Forest	411	Pine Flatwoods
				412	Longleaf Pine
				413	Sand Pine Scrub
				414	Other
		420	Hardwood Forest	421	Xeric Oak
				422	Other Hardwood
		430	Mixed Forest	431	Mixed Forest
		440	Planted Forest	441	Coniferous
				442	Hardwood
		450	Clearcut Areas	451	Clearcut
500	Water	510	Streams and Canals*	511	Streams
				512	Streams with Grass Beds
				513	Canals
				514	Canals with Grass Beds

*See method for hydrologically ordering streams, bays, and basins in Table C.2.2. Features such as marine grass beds, coral reefs, and oyster beds may be identifiable with Level II imagery.

TABLE C.2.1. (Continued)

LEVEL I	LEVEL II	LEVEL III
NO. LAND USE/COVER	NO. LAND USE/COVER	NO. LAND USE/COVER
500 Water (Cont'd)	520 Lakes*	521 Lakes
		522 Lakes with Grass Beds
	530 Reservoirs*	531 Reservoirs
		532 Reservoirs with Grass Beds
	540 Bays and Estuaries*	541 Bays
		542 Bays with Marine Grass Beds
		543 Bays with Oyster Bars
		544 Estuaries
		545 Estuaries with Marine Grass Beds
		546 Estuaries with Oyster Bars
	550 Open Marine Waters	551 Open Marine Waters
		552 Open Marine Waters with Marine Grass Beds
		553 Open Marine Waters with Oyster Bars
		554 Open Marine Waters with Coral Beds
	560 Other Water Areas	561 Ponds
		562 Ponds with Grass Beds
		563 Other Water Areas
600 Wetlands	610 Wetland - Coniferous Forest	611 Cypress
		612 Pond Pine
	620 Wetland - Hardwood Forest	621 Freshwater Swamp
		622 Saltwater Swamp (Mangroves)
	630 Wetland - Mixed Forest	631 Mixed Forest
	640 Wetland - Vegetated Non-Forested	641 Freshwater Marsh
		642 Saltwater Marsh
	650 Non-Vegetated Wetland	651 Tidal Flats
		652 Other Non-Vegetated Wetlands
700 Barren Land	710 Beaches	
	720 Sand Other than Beaches	
	730 Exposed Rock	
	740 Altered Lands	741 Scraped Areas
		742 Dredge and Fill
		743 Spoil Banks
	750 Extractive	751 Mineral Extraction
		752 Stone Quarries
		753 Sand, Gravel, Clay
		754 Oil and Gas Wells
		755 Abandoned Mining Operations
	760 Other Barren Lands	

*See method for hydrologically ordering streams, bays, and basins in Table C.2.2. Features such as marine grass beds, coral reefs, and oyster beds may be identifiable with Level II imagery.

TABLE C.2.2. METHOD OF HYDROLOGICALLY ORDERING BAYS, STREAMS, AND LAKES

For water planning purposes, it may be necessary to more closely describe water bodies. The method of identifying and hydrologically ordering streams, bays, and basins in Florida used by the Florida Departments of Natural Resources and Environment Regulation is described as follows:

BAYS

First Order Bays

All bays which open directly into the Gulf of Mexico or the Atlantic Ocean.

Second Order Bays

All bays which open into first order bays.

Third and Higher Order Bays

All bays which open into second order bays are called third order bays. Those bays which open into third order bays are called fourth order bays and so on until the bays to be hydrologically ordered are exhausted.

STREAMS, CANALS, AND THEIR TRIBUTAIRES

First Order Streams and First Order Canals

First order streams and canals are all those which flow directly into saltwater; that is, the Gulf of Mexico, the Atlantic Ocean or any of the bays and sub-bays which flow directly or indirectly into these two bodies.

Second Order Streams and Second Order Canals

Second order streams and canals are all those which flow into first order streams or canals.

Third and Higher Order Streams and Third or Higher Order Canals

All streams and canals which flow into second order streams or canals are called third order streams or canals. Those streams and canals which flow into third order streams or canals are called fourth order streams or canals and so on, until the streams or canals to be hydrologically ordered are exhausted.

LAKES AND RESERVOIRS

Lakes and reservoirs are ordered by size and hydrologically by type as follows:

First Order Lakes -- Lakes whose surface area is greater than 500 acres.

Type 1: Lakes with streams flowing into them
Type 2: Lakes with streams flowing out of them
Type 3: Lakes and reservoirs with streams flowing out a man-made control structure
Type 4: Lakes with streams flowing both in and out of them
Type 5: Lakes and reservoirs with streams flowing both in and out of them with man-made control structures
Type 6: Lakes that are landlocked

Second Order Lakes -- Lakes whose surface area is greater than 40 acres but less than 500 acres.

Types: Same as first order lakes

Third Order Lakes -- Lakes whose surface area is greater than 10 acres but less than 40 acres.

Types: Same as first order lakes

Fourth Order Lakes -- Lakes whose surface area is less than 10 acres.

Types: Same as first order lakes

TABLE C.2.3. CLASSIFICATION SYSTEM USED IN THE 1976 FLORIDA LAND USE INVENTORY PREPARED BY USGS IN CO-OPERATION WITH THE DIVISION OF STATE PLANNING

NO.	LAND USE	NO.	LAND USE
A.	Basic Classification System		
	Level I		Level II
1	Urban and Built-up Land	11	Residential
		12	Commercial and Services
		13	Industrial
		14	Transportation, Communications and Utilities
		15	Industrial and Commercial Complexes
		16	Mixed
		17	Other
2	Agricultural Land	21	Cropland and Pasture
		22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas
		23	Confined Feeding Operations
		24	Other
3	Rangeland	31	Herbaceous Range
		32	Shrub-Brushland Range
		33	Mixed
4	Forest Land	41	Deciduous
		42	Evergreen
		43	Mixed
5	Water	51	Streams and Canals
		52	Lakes
		53	Reservoirs
		54	Bays and Estuaries
		55	Other
6	Wetland	61	Forested
		62	Non-forested
7	Barren Land	71	Salt Flats
		72	Beaches
		73	Sandy Areas Other than Beaches
		74	Bare Exposed Rock
		75	Strip Mines, Quarries, and Gravel Pits
		76	Transitional Areas
		77	Mixed

B. Supplementary Land Use Data to be Shown in Separate Map Overlays

1	Institutional Uses	5	Mangroves
2	Citrus Groves	6	Cypress
3	Transportation Canals and Waterways	7	Planted Pine
4	Wetland Forest, Deciduous, Evergreen, Mixed	8	Non-forested Wetlands
		A	Vegetated
		B	Bare

C.3: MICHIGAN LAND COVER/USE CLASSIFICATION SYSTEM

The Michigan classification system was developed by a committee because there did not exist any complete or co-ordinated source of information on present cover or uses of Michigan land. While land use inventories were carried out periodically by various agencies of government, these were achieved without consistency of measurement between them.

Many types of classification systems have been developed and used in investigating human and natural resources nationally and in Michigan. Vestiges of several systems persist and they are in use by local, state, and federal agencies. Two major difficulties attend this arrangement, however. There was no one land cover/use classification system which found general acceptance for use at the state level; and given increasing activity and concern for land use at the local level, there was perceived to be an urgent need to establish a comprehensive, flexible, and standardized system. This system would have to be acceptable to most practitioners to permit data aggregation and disaggregation at lower costs to all involved.

The specific objectives of the committee were to:

1. "develop a classification system for use by land planners and others who rely upon remote sensed imagery as a primary data source,
2. "develop a classification system that relies on remote sensed imagery and also relies upon ground data collection, especially at the lower or more detailed levels of classification;
3. "develop a consistent and comprehensive set of definitions for land cover/use activities or mapping elements used in the system;
4. "evaluate and recommend base mapping standards, scales, levels, and referencing systems; and
5. "initiate development of an inventory process for use by Michigan's Office of Land Use." (Michigan Land Use Classification and Referencing Committe, 1976).

On the matter of how best to describe the system, the committee reported:

> "The compound term "land use/cover" has been applied, since neither word alone suffices to express the total system. For two of the major categories, 'agriculture' and 'urban and built-up', the terms express or imply the land use 'activity' which is taking place. For the other five major categories, the terminology does not directly or implicitly describe the activity that may be taking place on the land. Forest land, for instance, may be used for any one or more of several activities -- e.g., timber production, wildlife production, hunting, grazing, wildlife sanctuary, recreation, natural area preservation, or amenity-consumptive purposes in connection with adjacent residential or other land uses. 'Cover' has long been used to express what is found on the surface of non-urban land. There are, however, those who would defend the application of the term cover to include, for instance, 'residential' and 'row crop' land uses."

The committee recommended adoption of a four-level hierarchical land cover/use classification system based upon the 1972 USGS classification system (Anderson *et al.*, 1971) and subsequent revisions to that system. The nine categories of USGS Level I classification were adopted (*see* C.1) and at Level II adapted the USGS system to Michigan conditions (Table C.3.1). In recommending a complete system through Levels III and IV,

the objective was "to provide an integrated and consistent system, permitting aggregation from the lowest level upward into each successively higher level, or the disaggregation of any higher level into lower levels". It was also agreed that while the USGS classification system is cover-oriented (e.g. vegetative) the Michigan system should be both cover and activity-oriented at Level IV to more adequately meet user needs at regional and local levels. Portions of the Michigan classification system incorporating Levels I through IV are shown in Table C.3.2.

> "In developing Level IV categories for Urban and Built-up, the committee agreed that it would be advisable to utilize so far as possible the Standard Land Use Classification Manual (SLUC) and Standard Industrial Code (SIC) classification. Many local users are already using or are familiar with the SLUC and SIC systems, with Levels II and III providing the bridge. SLUC and SIC system numbers are included for cross reference purposes, in association with each number utilized in this new system, where applicable.
>
> "Committee members felt that the development of Levels V and VI (or even more detailed functional levels) should be the prerogative of individual units or lower levels of government, to the extent that they have need for such additions to the system. The committee recommended, moreover, that if local government or user groups do require further breakdown into Level V, etc., that this be accomplished within the framework of the system as here set forth. This will accomplish the desired objectives of uniformity of application of Levels I through IV, with potential for aggregation of any level to each of the higher levels." (Michigan Land Use Classification and Referencing Committee, 1976).

The classification system will be most satisfactorily presented when different map scales are used for the different levels of classification. The smallest size area that may be displayed is a function of map scale and drafting requirements. In the Michigan situation, the smallest unit that can be outlined and delineated is an area 3 x 5 mm and, because the classification codes are four-digit numbers, the areas delineated must be large enough to permit a four-digit number to be placed legibly inside. Information on preferred scales of mapping at different levels of the system are also summarized.

It is improbable that a land cover or use map of the whole state can be compiled at a scale larger than 1:250,000 (using Level I and II categories) and the largest map scale for recording Level IV information has been recommended at 1:24,000. The committee suggested that certain specifications be adopted for conventional mapping at a scale of 1:24,000 using the Michican land cover/use classification system.

1. "No area will be recognized as a separate unit unless it is at least two acres in size.
2. "Areas less than 200 feet wide will not be shown except as acute corners of larger types (the two-acre minimum also applies to linear types).
3. "All map units shall be assigned a four-digit land use code. If classes do not exist, or are not used at any given level(s), insert zeros to fill out the four-digit code (e.g., 6120, 5200, 3000).
4. "If a mapped unit meets the definitions for two, or more, land cover/use classes, the higher order (lower number) classification shall be assigned.
5. "Double coding is permissible providing that the dominant class is indicated first."

Detailed definitions for the classification system have been provided. Levels I and II definitions are based on the USGS precedent, but modified to satisfy the Michigan situation. Level III and IV

definitions are taken from existing functional definitions or they were developed by the committee. Standard Land Use Coding Manual (SLUC) categories and, when appropriate, Standard Industrial Code (SIC) categories are included with the definitions for reference by the reader of the Urban category. In some instances, too, appropriate SLUC categories are identified as the basis for Level V categories. For example:

"1271 Cultural, indoor
12711 Libraries (SLUC 7111)
12712 Museums (SLUC 7112)
12713 Art galleries (SLUC 7113)
12714 Planetariums (SLUC 7121)
12715 Aquariums (SLUC 7122)
12716 Historic buildings (SLUC 7191)
12719 Other (SLUC 7119)"

Certain constraints are apparent in the system. For example, many mappable land information factors such as land ownership and dedication were excluded from the system.

> "The system classifies land use/cover independent of the ownership factor, even as between public and private ownership, and independent of management intent. For instance, "farmlands" are not identified as such. Farmland can include several use/cover categories (e.g. Forest Land) in addition to those categories included under Agricultural. Also some Agriculture categories can be found on land managed other than as farmland. Similarly, State and National Forest areas and other classes of public land are not identified as such within the system. Nor is the system intended to encompass the identification of public or private lands managed and dedicated for such uses as Wildlife Areas or Parks. All of these factors are readily susceptible of independent mapping and inventory. Political boundaries, including municipal corporation limits are also not part of the system. Urban and Built-up land is, as defined within this system, mapped or inventoried completely independent of location with respect to city limits. A striking example is a campground within a wilderness park which is here classified as Urban or Built-up..."

The committee points out that other inventory phases may be, where required, superimposed on the land use/cover map. And finally, as noted in other systems utilizing the USGS approach, the land use/cover map system developed for Michigan is not a land use potential map. In most instances, it will be utilized to collect inventory information on certain aspects of land and an additional array of factors, identified in part in Classification System C.1, will be required to contribute to the land planning process.

TABLE C.3.1. PROPOSED LEVELS I AND II, MICHIGAN LAND COVER/USE CLASSIFICATION SYSTEM

LEVEL I		LEVEL II	
NO.	LAND COVER/USE	NO.	LAND COVER/USE
1	Urban and Built-up	11	Residential
		12	Commercial, Services and Industrial
		13	Industrial
		14	Transportation, Communication and Utilities
		(15)	Map Industrial Parks under appropriate category in Commercial Services and Institutional (12) or Industrial (13)
		16	Mixed
		17	Extractive
		19	Open and Other
2	Agricultural Land	21	Cropland, Rotation and Permanent Pasture
		22	Orchards, Bush-Fruits, Vineyards and Ornamental Horticultural Areas
		23	Confined Feeding Operations
		(24)	Inactive Land (These plant communities will be mapped under herbaceous rangelands (31)
		29	Other Agricultural Land
3	Rangeland	31	Herbaceous Rangeland
		32	Shrub Rangeland
4	Forest Land	41	Broadleaved Forest (generally deciduous)
		42	Coniferous Forest
		43	Mixed Conifer-Broadleaved Forest
5	Water	51	Streams and Waterways
		52	Lakes
		53	Reservoirs
		54	Great Lakes
6	Wetlands	61	Forested (wooded) Wetlands
		62	Non-Forested (non-wooded) Wetlands
7	Barren	71	Salt Flats (not applicable to Michigan)
		72	Beaches and Riverbanks
		73	Sand Other than Beaches
		74	Bare Exposed Rock
		75	Transitional Areas
		79	Other
8	Tundra (not applicable to Michigan)		
9	Permanent Snow and Ice (not applicable to Michigan)		

TABLE C.3.2. PART OF PROPOSED MICHIGAN LAND COVER/USE CLASSIFICATION SYSTEM

LEVEL I	II	III	IV	LAND COVER/USE
1				URBAN
	11			Residential
		111		Multi-family, medium- to high-rise
			1111	High density
			1112	Medium density
			1113	Low density
		112		Multi-family, low-rise
			1121	High density, apartment
			1122	Medium density, apartment
			1123	Low density, apartment
			1124	High density, townhouse
			1125	Medium density, townhouse
			1126	Low density, townhouse
		113		Single-family/duplex
			1131	High density
			1132	Medium density
			1133	Low density
			(1134)	Non-farm residence* (see category 291 for farmsteads)
			1135	Mobile home
			1136	Seasonal dwelling
			1139	Other
		114		Strip residential
			1141	High density, shoreline
			1142	Medium density, shoreline
			1143	Low density, shoreline
			1144	High density, roadside
			1145	Medium density, roadside
			1146	Low density, roadside
		115		Mobile home parks
			1151	High density
			1152	Medium density
			1153	Low density
		116		Group and transient quarters
			1161	Rooming and boarding houses
			1162	Membership lodging
			1163	Residence halls and dormitories
			1164	Retirement homes and orphanages
			1165	Religious quarters
			1166	Residential hotels
			1167	Hotels, tourist courts, motels
			1168	Migrant quarters
			1169	Other

*Where numbers are bracketed, the class will ordinarily be mapped by the number to which cross-reference is made. The bracketed numbers are included primarily to facilitate aggregation on the national level.

TABLE C.3.2. (Continued)

LEVEL I	II	III	IV	LAND COVER/USE
1				URBAN (cont'd)
	12			Commercial, Services and Industrial
		121		Primary/central business district
			1211	Commercial
			1212	Services
			1213	Health
			1214	Education
			1215	Religious
			1216	Correctional
			1217	Military
			1218	Government administration and services
			1219	Other commercial, services, and institutional
		122		Shopping Centre
			1221	Commercial
			1222	Services
			1223	Health
			1224	Education
			1225	Religious
			1226	Correctional
			1227	Military
			1228	Government administration and services
			1229	Other commercial, services and institutional
		123		Strip development
			1231	Commercial
			1232	Services
			1233	Health
			1234	Education
			1235	Religious
			1236	Correctional
			1237	Military
			1238	Government administration and services
			1239	Other commercial, services, and institutional
		124		Secondary, neighborhood business district
			1241	Commercial
			1242	Services
			1243	Health
			1244	Education
			1245	Religious
			1246	Correctional
			1247	Military
			1248	Government administration and services
			1249	Other commercial, services, and institutional
		125		Other commercial and services
			1251	Grain, feed, and seed
			1252	Livestock sales
			1258	Other commercial
			1259	Other services

TABLE C.3.2. (Continued)

LEVEL I	II	III	IV	LAND COVER/USE
1				URBAN (Cont'd)
	12			Commercial, Services and Industrial (Cont'd)
		126		Other institutional
			1263	Health
			1264	Education
			1265	Religious
			1266	Correctional
			1267	Military
			1268	Government administration and services
			1269	Other
		127		Indoor cultural, public assembly, and recreation
			1271	Indoor cultural
			1272	Indoor public assembly
			1273	Indoor recreation
2				AGRICULTURAL LAND
	21			Cropland, Rotation and Permanent Pasture
		211		Cultivated cropland
			2111	Row crops
			2112	Small grains
			2119	Other
		212		Hay, rotation and permanent pasture
			2121	Hay
			2122	Rotation pasture
			2123	Permanent pasture
			2129	Other
	22			Orchards, Bush-Fruits, Vineyards and Ornamental Horticulture Areas
		221		Tree fruits
			2211	Apples
			2212	Cherries
			2213	Peaches
			2214	Pears
			2215	Plums and prunes
			2219	Other
		222		Bush-fruits and vineyards
			2221	Strawberries
			2222	Raspberries
			2223	Blueberries
			2224	Grapes
			2229	Other
		223		Ornamental horticultural
			2231	Sod
			2232	Floriculture
			2233	Nurseries
			2239	Other

TABLE C.3.2. (Continued)

LEVEL I	II	III	IV	LAND COVER/USE
2				AGRICULTURAL (Cont'd)
	23			Confined Feeding Operations
		231		Livestock
			2311	Beef
			2312	Dairy
			2313	Swine
			2319	Other
		232		Poultry
			2321	Chickens
			2322	Turkeys
			2329	Other
	(28)			Inactive Land (These plant communities will be mapped under herbaceous rangelands (11))
	29			Other Agricultural Land
		291		Farmsteads
			2991	Farmstead with active residence
			2992	Farmstead without active residence
		292		Greenhouses and mushroom houses
			2921	Vegetables
			2922	Flowers
			2923	Mushrooms
			2929	Other
		293		Racetracks
		299		Other
3				RANGELAND
	31			Herbaceous Rangeland
		311		Upland herbaceous rangeland
			3111	Bluegrasses predominate
			3112	Quackgrass predominates
			3113	Bluestems, upland sedges, dewberry mosses, and lichens
			3114	Beach grass predominates
			3119	Other upland herbaceous openings
		312		Lowland herbaceous rangeland
			3121	Reed canary grass predominates
			3122	Clovers predominates
			3123	Red top predominates
			3124	Sedges predominate
			3125	Blue-joint predominates
			3129	Other lowland herbaceous openings

TABLE C.3.2. (Continued)

LEVEL I	II	III	IV	LAND COVER/USE
3				RANGELAND (Cont'd)
	32			Shrub Rangeland
		321		Upland shrub rangeland
			3211	Briars predominates
			3212	Dogwood predominates
			3213	Hazel predominates
			3124	Juneberry predominates
			3125	Sumac predominates
			3126	Thornapple predominates
			3127	Viburnum predominates
			3128	Sweet fern
			3129	Other upland shrublands
		(322)		Lowland shrub rangelands (for Level III use wetlands 612)
4				FOREST LAND
	41			Broadleaved Forest (generally deciduous)
		411		Upland hardwoods
			4111	Sugar maple predominates
			4112	Red maple predominates
			4113	Elm predominates
			4114	Beech predominates
			4115	Yellow birch predominates
			4116	Cherry predominates
			4117	Red oak predominates
			4118	White oak predominates
			4119	Other upland hardwoods
		412		Aspen, white birch, and associated species
			4121	Trembling aspen predominates
			4122	Bigtooth aspen predominates
			4123	Balm-of-gilead predominates
			4124	White birch predominates
		413		Lowland hardwoods
			4131	Ash predominates
			4132	Elm predominates
			4133	Red maple predominates
			4139	Other lowland hardwoods
	42			Coniferous Forest
		421		Upland conifers
			4211	White pine predominates
			4212	Red pine predominates
			4213	Jack pine predominate
			4214	Scotch pine predominates
			4215	White spruce predominates
			4219	Other
		422		Lowland conifers
			4221	Cedar predominates

TABLE C.3.2. (Continued)

LEVEL I	II	III	IV	LAND COVER/USE
4				FOREST LAND (Cont'd)
	42			Coniferous Forest (Cont'd)
		422		Lowland conifers (Cont'd)
			4222	Black spruce predominates
			4223	Tamarack predominates
			4224	Balsam fir-white spruce association predominates
			4225	Balsam fir predominates
			4229	Other
	43			Mixed Conifer-Broadleaved Forest
		431		Upland hardwoods and pine associations
			4311	Sugar maple predominates
			4312	Red maple predominates
			4313	Elm predominates
			4314	Beech predominates
			4315	Yellow birch predominates
			4316	Cherry predominates
			4317	Red oak predominates
			4318	White oak predominates
			4319	Undifferentiated broadleaved or deciduous forest
		432		Aspen, birch with conifer associations
			4321	Trembling aspen predominates
			4322	Bigtooth aspen predominates
			4323	Balm-of-gilead predominates
			4324	White birch predominates
		433		Lowland hardwoods with cedar, spruce, tamarack, etc., associations
			4331	Ash predominates
			4332	Elm predominates
			4333	Red maple predominates
			4339	Other lowland hardwoods
		434		Upland conifers with maple, elm, ash, aspen and birch, etc., associations
			4341	White pine predominates
			4342	Red pine predominates
			4343	Jack pine predominates
			4349	Other
		435		Lowland conifers with maple, elm, ash, aspen, birch, etc., associations
			4351	Cedar predominates
			4352	Black spruce predominates
			4353	Tamarack predominates
			4354	Spruce - balsam - birch association
			4355	Balsam fir predominates
			4356	White spruce predominates
			4359	Other
5				WATER
	51			Streams and Waterways
		511		Small streams and rivers
		512		Medium streams and rivers

TABLE C.3.2. (Continued)

LEVEL I	II	III	IV	LAND COVER/USE
5				WATER (Cont'd)
	51			Streams and Waterways (Cont'd)
		513		Large streams and rivers
	52			Lakes
		521		Ponds
		522		Small Lake
		523		Small Lake
		524		Medium Lake
		525		Medium Lake
		526		Large Lake
		527		Large Lake
		528		Very Large Lake
		529		Very Large Lake
	53			Reservoirs
		531		Ponds
		532		Small Reservoirs
		533		Small Reservoirs
		534		Medium Reservoirs
		535		Medium Reservoirs
		536		Large Reservoirs
		537		Large Reservoirs
		538		Very Large Reservoirs
		539		Very Large Reservoirs
	54			Great Lakes
6				WETLANDS
	61			Forested (wooded) Wetlands
		(611)		Wooded swamps (mapped under forestry categories 412, 422, 433, 435)
		612		Shrub swamps
			6121	Alder predominates
			6122	Dogwood, viburnum and willow associations
			6123	Sweetgale-bogbirch associations
			6124	Leatherleaf predominates
			6125	Willow-buttonbush associations (greater than 50% cover -- more than 6 in. water)
			6126	Willow-buttonbush associations (less than 50% cover -- more than 6 in. water)
			6127	Water willow predominates
			6128	Standing dead trees, shrubs, and stumps
			6129	Other
	62			Non-Forested (non-wooded) Wetlands
		(621)		Marshland meadow (grazed meadows will be mapped under permanent pasture 2123. Ungrazed meadows will be mapped lowland herbaceous rangeland 312)
		622		Mudflats
		623		Shallow marshes
			6231	Cattail predominates

TABLE C.3.2. (Continued)

LEVEL I	II	III	IV	LAND COVER/USE
6				WETLANDS (Cont'd)
	62			Non-Forested (non-wooded) Wetlands (Cont'd)
		623		Shallow marshes (Cont'd)
			6232	Bur reed, bulrushes, sedges, blue-joint
			6233	Smartweed, mud plantain, pickerel weed, arrow arum, and arrowhead
			6239	Other
		624		Deep marshes
			6241	Cattail predominates
			6242	Bur reed, rushes and sedges
			6243	Smartweed, mud plantain, pickerel weed, arrow arum, and arrowhead
			6244	Water lily, watershield, and lotus
			6249	Other
		(625)		Open water (refer to Water 5)
7				BARREN
	71			Salt Flats (not applicable to Michigan)
	72			Beaches and Riverbanks
		721		Sand beach
		722		Gravel beach
		723		Riverbanks
		729		Other
	73			Sand other than Beaches
		731		Sand dunes
		739		Other
	74			Bare Exposed Rock
		741		Rock knobs
		742		Escarpments
		743		Shoreline rock outcrop
		744		Riverbank
		749		Other
	75			Transitional Areas
	79			Other
8				TUNDRA
9				PERMANENT SNOW AND ICE (not applicable to Michigan)

C.4: PRINCE EDWARD ISLAND PRESENT LAND USE

The present land use (PLU) map of Prince Edward Island currently is in the stage of development and refinement. Information at hand for the development of present land use include a soil map (1:10,000), property boundaries and numbers maps (1:5,000), present land use (partial, at 1:5,000), and assessment status sheets. The system, when fully developed, probably will be derived from the Michigan Land Cover/Use Classification System (Classification System C.3, as derived from the USGS, C.1), but will incorporate additional digits to accommodate more detailed breakdowns (Table C.4.1). The resources of the Canada Geographic Information System (CGIS) also may be utilized (Can., Environment Can., 1973; 1977a and b).

At present, there is no forestry information on the present land use map other than height and kind of regrowth. Those involved in developing the land use information wish to include forestry information as part of the PLU rather than as a separate input. F. Wilson of the PEI Land Use Service Centre reported:

> "The delineations would be about as complex as the soil information but with a simpler legend. The material we have on hand includes a 3-digit stand number, a 2-digit stand kind, a one-digit maturity class, and a one-digit height class. As much of this information is now about 10 years old, some modification likely will be required. For things like forested and non-forested wetlands (61 and 62 U.S.) we would expect to get the 'wetland' areas from the soils information and then classify the cover.
>
> "With farmsteads, and some others, we envisage a two-scale effort -- the 1:10,000's identifying farmsteads (as in the Michigan example) and something larger showing building location, quality, and perhaps other information from the Assessment Branch ...* In similar vein to the farmstead situation, the 1:10,000's could show the existence of a hydro or telephone line, and the larger scale (would) indicate the particulars thereof." (Wilson, 1978: pers. comm.).

No additional details on this classification system are at hand.

*See Classification System B.11 for comment on apparent restrictions on the availability of information from the PEI Land Valuation and Assessment Division.

TABLE C.4.1. PART OF PROPOSED LAND USE CLASSIFICATION FOR PRINCE EDWARD ISLAND

LEVEL I	LEVEL II	LEVEL III	LAND USE	ADDITIONAL CODES
1			URBAN AND BUILT-UP	
	12		COMMERCIAL, SERVICES, AND INDUSTRIAL	
			- country stores	
			- autobody shops	
			- service stations	
			- schools	
			- churches	
			- community centres	
			- cement plants	
			- asphalt plants	
			- eating establishments	
	14		TRANSPORTATION, COMMUNICATION, AND UTILITIES	
		146	UTILITIES	
			- petroleum storage	
			- solid waste disposal	
			- sewage treatment	
			- borrow pits	
			- paved roads	
			- dirt roads	
			- trails	
	19		OPEN AND OTHER	
		192	OUTDOOR PUBLIC ASSEMBLY	
			- drive-in movies	
			- racetracks (commercial)	
			- fairgrounds	
		193	OUTDOOR RECREATION	
			- landscaped and aesthetic areas	
			- play, games, and athletics	
			- sport areas (golf, driving ranges, shooting ranges, off road vehicle tracks)	
	21		CROPLAND, ROTATION, AND PERMANENT PASTURE	
		211	CULTIVATED CROPLAND	
			- Row Crops	
			- potatoes	PT
			- tobacco	TB
			- turnips	TR
			- corn (silage)	CS
			- peas (canning)	PC
			- corn (sweet)	CN
			- beans	BN
			- carrots	CT
			- beets	BT
			- parsnips	PR
			- onions	ON
			- tomatoes	TM
			- cabbage	CB
			- cauliflower	CU
			- pumpkins	PM
			- cucumber (garden)	CG
			- cucumber (pickling)	CP
			- lettuce	LT
			- brussel sprouts	BS
			- broccoli	BC

TABLE C.4.1. (Continued)

LEVEL I	LEVEL II	LEVEL III	LAND USE	ADDITIONAL CODES			
		211	CULTIVATED CROPLAND (Cont'd)				
			- Small Grains				
			- wheat	WH			
			- oats	OT			
			- barley	BR			
			- grains mixed	GM			
			- grain and peas	GP			
			- winter wheat	WW			
			- fall rye	FR			
			- field peas	FP			
			- buckwheat	BW			
			- fallow (green manure)	F			
			- recent clearing	CR			
		212	HAY AND PASTURE				
			- hay-grass	HG			
			- hay-grass legume	HGL			
			- hay-legume	HL			
			- pasture-grass	PG			
			- pasture-grass legume	PGL			
			- pasture-legume	PL			
			- pasture-poor-weedy	PP			
	22		ORCHARDS, BUSH FRUITS, ORNAMENTAL HORTICULTURAL AREAS				
		221	TREE FRUITS				
			- apples				
			- cherries				
			- pears				
			- plums				
		222	BUSH FRUITS				
			- strawberries				
			- raspberries				
			- blueberries				
		223	ORNAMENTAL HORTICULTURE				
			- floriculture				
			- nurseries				
	23		CONFINED FEEDING OPERATIONS				
			- beef				
			- dairy				
			- swine				
			- chickens				
			- turkeys				
			- fox				
			- mink				
	28		INACTIVE LAND				
			- idle grass	IG			
			- idle grass legume	IGL			
			- idle legume	IL			
			- idle grass and weeds	IW			
			- regrowth - alders	RA		Height (feet)	
			- regrowth spruce-tamarack	RS	< 5	5 - 10	>10
			rose-bayberry	RB	1	2	3

C.5: STATE OF IDAHO PROPOSED UNIFORM LAND USE CLASSIFICATION SYSTEM

This proposed uniform land use classification system was prepared by Idaho's State Planning and Community Affairs Agency for its own use in 1973. The system was developed in co-operation with the Federation of Rocky Mountain States (Colorado, Idaho, Montana, New Mexico, Utah, and Wyoming) and it was formally adopted by the Federation in 1972. The classification system:

> "is essentially a regional adaptation of the USGS system, with additional categories to fit some of the region's particular mountain and desert geography. Of particular importance to the Federation's system is inclusion of the category (2.0) scattered, built-up. That category includes the land area undergoing the greatest change. It is the Federation's position that these additional categories can be handled in the ... USGS mapping from remote sensing and high altitude photography." (Porter, 1973).

The objective of the system is to place information available about land uses into an orderly form so that it can be readily understood and systematically used. Added incentives have included first, the need to bridge the widening gap between the new technology which makes available remotely sensed information and the more-traditional methodology for gathering and utilizing earth-resource data. Secondly, the Federation of Rocky Mountain States has as an objective the resolution of regional planning problems. One of the Federation's councils, the Regional Planning Council, had as a major project the development of a uniform land use classification system.

In 1971, Mollohan reported on the rationale and theory for a classification system. Certain necessary rules were developed to approach a common system for Level I classification suggested by the Federation. These were as follows:

1. "'Hundred Percent' Rule There may be no dual counting of land areas under different classifications, because the resulting total would exceed 100 percent of the state land area.

2. "Minimum Area of Averaging Rule For the large land uses, at least one-half section of land should have at least 90 percent utilization to be identified as that use.

3. "Rule for the Breakline for Scattered Built-Up Land Use This category must somehow be defined by density limits on dwelling units, visible on aerial photography. These will separate it from the less dense agricultural or forest land classes. The upper break point is one family unit per two acres (averaged over one-half section of land); and the lower break point, one family unit per ten acres.

4. "'Visibility-Scale' Rule for All Other Land Uses Important spot uses such as transportation, utilties, mining and outdoor recreation installations must be readily identified on standard USGS maps or photography.

5. "Rule of 'Logical Function' If a land use category is firmly established in a state functional planning such as highways, recreation, water, etc., and if it is the subject of physical projection and major budgeting, it seems logical to include it as a first order category.

6. "Rule of Grid Mapping Conversion It may become necessary for the State Planning Agency to use a cellular mapping procedure for projections and simulation work. If a grid system is contemplated for projection work, it may also be used for rough survey work where the section lines (or any subdivision thereof) are directly available. The choice depends on the degree of detail desired, and this depends on the location. For example, quarter sections are logical in urbanized areas; and full sections may be adequate in rural areas." (Mollohan, 1971).

At subsequent meetings of the Federation there were reviews of each state's preliminary land use classification and analysis of the degree of inter-state consistency. Two technical papers were produced (Federation of Rocky Mt. States, 1972a and b) which identified a dual system with categories at Level I and Level II. The system, as finally accepted by the Federation, is shown on Table C.5.1.

The system when reviewed by state and federal agencies was considered to possess at least two shortcomings which are common to this type of classification. First, there is the difficulty of defining or determining differences in closely related areas. This contributes to a degree of inaccuracy (possible 10 per cent) in a generalized Level I and II classification system. Secondly:

> "The Idaho Department of Public Lands expressed the classic conflict in the development of first and second order land use classification systems -- the conflict of cover versus activity. The system proposed by the Federation is primarily an activity approach; however, certain second order classifications refer to ground cover which is not necessarily a reflection of the actual use or activity of the land. Actual activity probably could only be determined by a specific third and fourth level ground classification system, and not by high altitude remote sensing and aerial photography. Both cover and activity are needed in the system for practicality, even at the expense of a completely consistent system." (Porter, 1973).

C.6: STATE OF IDAHO, COMPREHENSIVE LAND USE PLANNING

In 1976, Idaho's Bureau of State Planning and Community Affairs issued a Planning Handbook for Local Governments. The Handbook was developed in response to the Local Planning Act of 1975 and had as its objective the establishment of long-range planning and environmental analysis procedures. "The product reflects efforts to develop guidelines to be used in the preparation and implementation of a comprehensive plan" (Idaho, Bureau of State Planning and Community Affairs, 1976).

The system for land use classification which has been in use for seven years is derived from: U.S. Department of Agriculture, Soil Conservation Service (1962); U.S. Geological Survey (Anderson et al., 1976); McHarg (1969); and local modifications.

A three-level system of mapping is recommended. State mapping is at Level I, county mapping at Level II, and city mapping at Level III. A flexible system is recommended that seeks agreement between agencies at Levels I and II while leaving Level III categories and other decisions to the discretion of local planners.

The classification scheme divides lands into eight Level I categories, each of which is subdivided into Levels II and III, but no decision criteria between or within levels are offered. The Level I categories are:

Urban and Built-Up
Agricultural Lands
Rangeland
Forest or Woodland
Water and Wetlands
Barren Land
Mining and Quarrying Lands
Transportation

City and county comprehensive plans constitute the principal products of the system.

TABLE C.5.1. STATE OF IDAHO, PROPOSED LAND USE CLASSIFICATION SYSTEM

LEVEL I NO.	LAND USE	LEVEL II NO.	GROUND COVER
1.0	Urban	1.1	Residential
		1.2	Commercial, service, office, and parking
		1.3	Primarily manufacturing and associated parking
		1.4	Extractive, sand and gravel, etc.
		1.5	Major transport routes, areas, terminals
		1.6	Water works, sewage plants, solid waste disposal
		1.7	Public and institutional other than above
		1.8	Extensive park land over 10 acres
		1.9	Other open land
2.0	Scattered, Built-up	2.1	Residential
		2.2	Commercial, services, office and associated parking
		2.3	Primarily manufacturing and associated parking
		2.4	Extractive, sand and gravel, etc.
		2.5	Major transport routes, areas, terminals
		2.6	Water works, sewage plants, solid waste disposal
		2.7	Public and institutional other than above
		2.8	Extensive parkland, over 10 acres
3.0	Agricultural	3.1	Cropland and pasture (irrigated)
		3.2	Cropland and pasture (dryland)
		3.3	Orchards, bush fruits, vineyards, and horticulture
		3.4	Feeding operations
4.0	Rangeland	4.1	Grass predominant
		4.2	Brush predominant
		4.3	Chaparral predominant
		4.4	Desert shrub
		4.5	Tundra
5.0	Forest Land	5.1	Deciduous
		5.2	Evergreen
		5.3	Mixed
6.0	Water Areas	6.1	Streams and waterways
		6.2	Lakes over 10 acres
		6.3	Reservoirs over 10 acres
		6.4	Year-round marsh over 10 acres
7.0	Barelands	7.1	Salt flats, over 10 acres
		7.2	Sand, over 10 acres
		7.3	Bare exposed rock, over 10 acres
		7.4	Glaciers and year-round snow field
		7.5	Beaches, over 1/4 mile
8.0	Mining or Quarrying	8.1	Stone, gravel, and extraction or storage
		8.2	Open pit mineral extraction
		8.3	Tailings, extensive over 10 acres
		8.4	Underground mining, working access areas
9.0	Energy and fuel production other than 8.0	9.1	Electric generation, major transmission corridors
		9.2	Gas wells, concentrated and pipeline corridors pre-empting other land use
		9.3	Oil wells, concentrated, and pipeline pre-empting other land use
		9.4	Geothermal wells and pipelines pre-empting other land
		9.5	Solar energy stations
10.0	Major Transportation (outside of areas 1.0 and 2.0)	10.1	Major transport routes, terminals, switching yards, airports
11.0	Major military and defense (outside of 1.0 and 2.0)	11.1	Military training camp, air station, or other substantially populated
		11.2	Extensive reservation, testing ground, or other minimum populated
12.0	Outdoor recreation purpose physical installations (outside 1.0 and 2.0)	12.1	Skiing, prepared slopes
		12.2	Large marinas, over 300 foot shoreline
		12.3	Large campsites over 10 acres

C.7: VEGETATION AND LAND USE MAP OF NEW MEXICO

The mapping exercise described here had as its objective the depiction of the vegetation and land use patterns of New Mexico insofar as they might be observed or inferred from small-scale satellite images. The product, a consistent map, would be used primarily for the purposes of planning management. A brief document accompanies the map and fully describes the system.

The classification system as developed by the Technology Application Center, University of New Mexico, Albuquerque, was designed to be integrated into the land use classification system developed for the United States Geological Survey (Anderson et al., 1976). The latter scheme was deliberately left incomplete at Levels III and IV to accommodate specific requirements of local authorities. Categories of the New Mexico system have been structured such that each has a level I and Level II equivalent in the USGS system. The correlations are listed in the document.

All areas outlined on the map are defined according to three factors: vegetation type, land use, and landform. These are keyed to colours, letters, and numbers respectively. There are five physiognomic groupings:

- Forests and Woodlands
- Shrubland and Shrub Savanna
- Grassland and Steppes
- Barren
- Cultivated

The following eight categories delineate the various types of land use:

- Agriculture
- Forestry (multiple use)
- Grazing
- Military
- Recreational
- No Dominant Use
- Extractive
- Urban

Landforms identified on LANDSAT imagery were divided into nine categories:

- Mountains and Hills
- Dissected Surfaces
- Bayada Surfaces
- Gently Rolling to Flat Terrain (including mesa tops)
- River Bottoms
- Scarps
- Lava Flows
- Enclosed Basins
- Volcanic Cones

The vegetation categories conform to the titles used by Küchler (1964) with modifications arising out of local conditions. Actual vegetation rather than potential natural vegetation is displayed. Data on vegetation types are supplemented by existing maps; land use and topographic data derived from the LANDSAT images; knowledge of existing ground cover; and information obtained from published sources.

The map was produced using 24 separate LANDSAT colour-composite transparencies at the scale of 1:1,000,000 as a mapping base. Colour composites were prepared from bands 4, 5, and 7 by the EROS Center in Sioux Falls, South Dakota. The USGS 1:1,000,000 township and range base map, together with the major cities and towns of the state, has been incorporated with the vegetation and land use information to provide a means of precise

geographic location. Soils, vegetation, biology, geology, and hydrology may be combined in any way through a computerized system.

Mapping of the entire state is in process. A vegetation-types map of the Socorro area was completed in 1976 from NASA U-2 high-altitude colour photography.

C.8: LAND USE IN IOWA: 1976, AN EXPLANATION OF THE MAP

The Land-Use in Iowa, 1976 map was prepared to provide generalized information about the contemporary use of land in Iowa. This is the first such map produced in the state and "it is intended to provide a synoptic view of the distribution of several categories of land-use within the state which, when used in conjunction with other resource data, may be useful in defining some management goals or policies" (Anderson, 1976). The map was prepared at a scale of 1:250,000 and printed at 1:500,000.

Manual photo interpretation of LANDSAT (formerly ERTS) I Satellite images by staff of the Iowa Geological Survey Remote Sensing Lab (IGSRSL) provided the base of information from which the land use map was prepared. LANDSAT was selected because it represented the only available source of imagery providing state-wide coverage which was both current and at a uniform, small scale. The images were produced by the LANDSAT Multi-spectral Scanner System which simultaneously acquires four coincident images at discrete spectral bands (4, 5, 6, and 7) in the visible and near-infrared portions of the electromagnetic spectrum. Each of the four bands may be considered to be individual images and although they are valuable sources of land use information, they are even more successful when combined as false-colour composite images.

Nine false-colour LANDSAT images were obtained for Iowa at a scale of 1:250,000 which permits direct comparison with U.S. Geological Survey 1 x 2 degree NK Series maps. Complete state coverage by the latter proved helpful in interpreting land use from the LANDSAT images. Moreover, use of this scale for map production permitted a 50 per cent reduction for the completed, printed map at 1:500,000, an arrangement which improves the appearance of the completed maps. Portions of Iowa not covered by acceptable LANDSAT imagery were photographed at 1:80,000 scale using colour-infrared aircraft photography.

Additional sources of photographic and non-photographic land use information served to verify LANDSAT interpretations. These sources (Table C.8.1) included photographs obtained by the Skylab S-190B camera in natural colour and at scales of 1:950,000; 1:500,000; and 1:150,000.

Nine land use categories were selected for display on the map and, in most instances, these were readily identifiable on the LANDSAT images. The categories are:

1. Urban Residential
2. Urban Commercial/Industrial
3. Urban Open
4. Transportation Network
5. Extractive Land
6. Agricultural Land
7. Forest Land
8. Water
9. Reservoir Flood Pools

Anderson (1976) provided a detailed account of the procedures followed in the production of the map. Interpretations of features on the 30" x 30" LANDSAT colour-infrared images were constantly cross-checked against the other data sources (see Table C.8.1). The interpreters began with areas of the state with which they were familiar and this permitted each individual to become skillful at identifying spectral reflectance characteristics of each of the land use categories.

Completed interpretations were transferred to a 1:250,000 scale base consisting of twelve individual maps. Each map included a grouping of counties chosen so that the areas of each map were nearly equal and their physical size would permit easy duplication by in-house equipment. Black-line ozalid copies of each were produced and the various land uses were colour coded. The coloured ozalid prints were then regrouped by counties to correspond with areas included in Iowa's multi-county regional planning agencies. These agencies then suggested corrections and other changes to the maps and, upon incorporation, the final map was produced.

None of the land use classifications interpreted from the LANDSAT imagery produced a unique, visual spectral response to the colour-infrared composites, and several factors (including hue and colour saturation, shape, size, and association with other features) had to be taken into consideration when determining land use in a given area. Anderson (1976) provided information on additional parameters introduced to determine individual land use categories.

The several techniques and many sources of data used to prepare the Iowa land use map and to verify LANDSAT interpretation have kept to a minimum the number of errors identified on the map. Also, the lack of an accurate base of comparison has hindered the determination of the map's accuracy.

Data on the time required to produce the map and the costs of production are available. Six and a quarter man-months was required to produce the map which included actual interpretation and checking with other imagery and maps, and averaged five man-days per area for each of the 12 multi-county groupings used. Another two and a quarter man-days per area was consumed through transferring, correcting, etc., for a total of 90 man-days of interpretation. An estimated 40 man-days was required to produce camera-ready copies of each of the 12 area maps. Production costs prior to printing were $6,780 and the cost to print 2,700 copies of Land-Use in Iowa: 1976 was $3,398 or a total of 18 cents per square mile.

C.9: COLORADO LAND USE CLASSIFICATION

The Colorado Land Use Classification System was published in 1976 by the Colorado Division of Planning (Burns, 1976). The objective is to develop a system which meets the need for a comprehensive, state-wide frame of reference for describing, analyzing, and mapping land use. The system will facilitate co-ordination of planning throughout the state. The system is one of several subsystems eventually intended to be incorporated into a state-wide geographic information system. Testing of the system has occurred at several locations in Colorado.

TABLE C.8.1. DATA SOURCES FOR IOWA LAND USE MAP PRODUCTION

DATA	USE	SOURCE
LANDSAT 30" x 30" colour enlargements (1972-75) Scale: 1:250,000	general land-use mapping	EROS Data Center Sioux Falls, S.D.
NASA Skylab Photography (1973-74) Scales: 1:2,800,000 and 1:950,000	used to check LANDSAT interpretations	EROS Data Center Sioux Falls, S.D.
IGS-SCS High Altitude Southern Iowa River (1975) Basin Study Photography Scale: 1:80,000	mapping regions of Southern Iowa not mapped from LANDSAT--also used to verify LANDSAT interpretations	Iowa Geological Survey Remote Sensing Lab. Iowa City, Iowa
NASA Cornblight Photography Scale: 1:120,000 (1972)	used to check LANDSAT interpretations	EROS Data Center Sioux Falls, S.D.
NASA High Altitude Des Moines (1973) to Omaha Flight Scale: 1:120,000	used to check LANDSAT interpretations	EROS Data Center Sioux Falls, S.D.
Non-Photographic Data		
USGS 1:240,000 scale N.K. Series Maps; NK 14-3, 14-6, 14-9, and NK 15-1 through 15-12	used to prepare county outlines on base map; verify city, highway, river, railroad, and reservoir locations	U.S. Geological Survey Iowa City, Iowa
1975 Official Highway Map of Iowa Scale: 1:825,000	used to verify city location and size, and highway location	Iowa Department of Transportation Ames, Iowa
Current Inventory and Transportation Map of Iowa (1974) Scale: 1:1,580,000	used to identify and locate principal railroads and airports	Iowa Department of Transportation Ames, Iowa
Sectional Aeronautical Charts, Omaha and Chicago Scale: 1:500,000	used to locate and identify principal airports	Federal Aviation Administration Local Airports
Iowa Highway Commission County Highway and Transportation Maps Scale: 1:250,000	used to locate and identify towns, roads, and extractive facilities	Iowa Department of Transportation Ames, Iowa
Mineral Resources of Iowa Scale: 1:500,000	used to check extractive facilities	Iowa Geological Survey Iowa City, Iowa

The system is based upon a "cultural landscape" approach; otherwise expressed as the condition found on the earth's surface as a result of the cumulative effect of human activity. The factors considered in the design of the system (which is described as hierarchic with three levels or orders of categories) include:

1. general landscape;
2. human environment;
3. conservation of land resources;
4. economic development; and
5. public and private costs related to land use.

The Level I (First Order) categories, which have been selected for maximum relevance to planning on the basis of their effect on the human environment, include:

Urban and Community Functions
Residential
Heavy Industry, Transportation, Utilities
Resource Extraction
Developed Recreation
Irrigated Farmland
Range Grazing
Low Impact Land Use
Major Military

In Level II categories further distinctions are made; for example, density/type of structure categories under the Level I Residential category (ski area, golf course, etc.). Written descriptions of Levels I and II categories are provided in the manual (Burns, 1976). These two levels are considered adequate for state and regional planning purposes.

Level III categories have been developed for each of the Level II categories of Urban and Community Function only, and further divide the Level II categories into specific uses. For example, within the Level II category of Major Public Buildings or Grounds stand Level III distinctions of Church, Library, Cemetery, etc. No need was found for Level III development under Level II categories other than the Urban and Community functions. Level III categories are listed but not described. At this third level the categories are intended for municipal and local, large-scale mapping. The level is open-ended.

The system may be applied at various scales depending upon planning requirements. However, it is intended primarily for application at 1:24,000 using USGS base maps and 1:24,000 quad-centred aerial-photo enlargements.

C.10: STATE OF MONTANA PROPOSED STATEWIDE LAND USE MAPPING PROGRAM

The Montana Department of Community Affairs, Planning Division has proposed a state-wide land use/land cover mapping program in response to the need for a one-time, single-year inventory of basic land information at a uniform map scale. The exercise would result in a mid-level land use classification system for the purpose of aiding state-level policy working decisions. Several federal and state agencies have co-operated in developing the system and a draft of land use descriptions had been completed by August 1976.

The proposed classification system possesses 11 categories, each of which is accompanied by short, qualifying descriptions. The categories are:

Urban and Community Land Uses
Heavy Industry and Utilities
Rural Subdivision Tracts
Mineral Extraction
Irrigated Cropland
Hayland and Pastureland
Non-Irrigated Cropland and Pasture
Recreational Use Areas
Rangeland
Commercial Forests
Barren Tundra and Marshland
Forest Cover

The mapping program would rely on information already compiled by agencies such as the Soil Conservation Service, U.S. Forest Service, Bureau of Land Management, and Montana's Department of Community Affairs.

The proposed medium-scale maps (1:125,000) would permit a minimum size of 40-acre cell to be shown, and thus would coincide with map scales in use by the Bureau of Land Management, the U.S. Forest Service, and the State Highway Department.

C.11: URBAN LAND USE IDENTIFICATION FROM HIGH-ALTITUDE AERIAL PHOTOGRAPHY

In 1972, Howarth and Neilly presented a paper in which they suggested that certain aspects of ground-based data collection (the pre-eminent data gathering procedure) can be effectively replaced in the land use mapping process by remotely sensed information derived from high-altitude small-scale photography. The information thus obtained "obviously relates to the morphology or physical aspects of the urban area, but in some cases it is possible to relate these to social and economic aspects of the urban system". The authors conceded that remote-sensing techniques would not replace ground-based surveys, but suggested that an integration of the two data sources could be more efficient and effective. They stated too, that use of consistent data source and the monitoring of land use data over time permits the establishment of a system for detection and analysis of land use change. This can be most effectively handled through a geographic information system. The authors went on to discuss the types of information that could be obtained within urban areas from high-altitude photography by using different films at different scales.

Howarth and Neilly (1972) recognized that the amount and type of information required by users clearly varies between regional and local studies. What land use information the planner may require is an uncertain element and whether or not more information would be advantageous to him is not known. In Table C.11.1, the classification categories used in land use maps for these specific purposes are displayed, together with a classification scheme derived by Wray (1960) from conventional aerial photography. Table C.11.2, which is a classification scheme developed by Simpson (1970) for a land use map of the Boston area, and recorded on 1:60,000 scale colour-infrared photography, contains much more detail than Table C.11.1. The authors suggested that employment of the USGS classification system (Simpson, 1970) or a derivative is most advantageous because it permits disaggregation to varying levels of detail.

High-altitude colour-infrared and panchromatic transparencies of the Hamilton/Niagara area at varying scales were examined

TABLE C.11.1. LAND USE CLASSIFICATIONS PRESENTLY IN USE

CLASSIFICATION	LAND USE
HAMILTON-WENTWORTH REGION	
	Residential
	Commercial
	Industrial
	Special Uses
	Recreation
REGIONAL MUNICIPALITY OF NIAGARA	
	Residential
	Resort Residential
	Commercial
	Shopping Centre
	Industrial
	Extractive
	Institutional
	Schools
	Hospitals
	Public Land
	Recreation
	Golf Courses
CITY OF HAMILTON	
	Residential
	Apartment House
	Commercial
	Industrial
	Institutional
	Schools
	Churches
	Parks, Playground and Open Space
	Special Uses
	Vacant Land
WRAY	
	Residential
	Commercial
	Industrial
	Transportation
	Open Improved
	Open Unimproved

TABLE C.11.2. LAND USE CLASSIFICATION APPLIED BY SIMPSON USING 1:60,000 SCALE COLOUR-INFRARED PHOTOGRAPHY

NO.	LAND USE
1.	Residential - single family.
2.	Residential - multi-family and mixed; Apartment complex
3.	Commercial - central business district; Shopping centre
4.	Industrial - including wholesale warehouses; Extractive gravel pits and quarries
5.	Institutional - including cemeteries; Waste disposal-sanitary fill, sewage plants, junk-yards
6.	Recreational - including outdoor theatres; Golf courses
7.	Cultivated land - row crops, cover crops, fallow; Orchard
8.	Non-cultivated land - open land, vacant lots, including pasture, marsh, and abandoned farms
9.	Woodland
10.	Water
11.	Transportation and utilities; Highway with interchanges Railroad Airport Railroad yard Transmission line Power plant or substation Water supply treatment plant

to determine their suitability for identifying land use categories. A qualitative assessment of the information content of the different sets of photography is shown on Table C.11.3. Colour-infrared photography at 1:60,000 scale presents no difficulties for the identification of basic land use types. The categories also can be differentiated at 1:137,000. In order to determine the extent to which scale influences the information content of colour-infrared film, two sets of photography of part of Hamilton, Ontario at nominal scales of 1:137,000 and 1:60,000 were examined. The information content was assessed by developing a land use classification scheme to increasing levels of detail.

On 1:137,000 scale photography, it was found possible to determine certain land use types to a three-digit level, but this exercise proved difficult and the degree of accuracy, in comparison with existing land use maps, was low. Prior knowledge of the area and its activities also was required. Thus, at scales of photography of 1:100,000 or smaller, only a two-digit level of determination of urban land use should be used.

On 1:60,000 scale photography, three-digit level information was readily discernible and occasionally four-digit level information could be identified (Table C.11.4). The authors suggested "that for both urban and regional land use classification, 1:60,000 scale colour infrared photography is an extremely efficient data source. The area covered on each photograph is approximately 80 square miles, so that large areas can be covered by comparatively few photographs." (Howarth and Neilly, 1972).

The authors addressed the problem of efficiently transferring land use information into map or computer-compatible form. The method recommended is the use of a Bausch and Lomb Zoom Transfer Scope which permits the interpreter (with a 14x enlargement capacity) to view both map base and transparency simultaneously and to transfer detail by tracing. The information recorded then may be drawn up in map form or digitized for input into a geographic information system.

Several applications of the land use information product derived from high-altitude aerial photography were suggested:

1. The rapid mapping of urban land use at isolated times to assist with urban planning decisions.
2. The detection of urban land use change between two or more moments in time.
3. The prediction of future urban land use change based on modelling and empirical observations of previous changes.
4. As an input to geographic information systems.
5. As an input to urban models and as a tool in the testing of such models.
6. For correlation with census and ground-survey data in order to relate physical aspects of the urban area to socio-economic variables.
7. To observe the effects on land use patterns of the interaction of small and large urban areas.

TABLE C.11.3. LAND USE IDENTIFICATION FROM DIFFERENT TYPES OF PHOTOGRAPHY

PHOTOGRAPHY	SCALE	TYPE	URBAN/ RURAL CONTRAST	RESI- DENTIAL	COMMER- CIAL	INDUST- RIAL	TRANS- PORTA- TION	OPEN IMPROV- ED	OPEN UNIM- PROVED
Colour infrared	1:60,000	Transp.	1	1	1	1	1	1	1
Colour infrared	1:137,000	Transp.	2	1	2	1	1	1	2
Colour infrared	1:240,000	Transp.	3	3	3	3	2	3	3
Colour infrared	1:66,000 (enlarged from 1:240,000)	Transp.	4	4	4	4	3	4	4
Panchromatic (red band)	1:160,000	Paper print	3	2	3	3	2	3	3
Panchromatic (red band)	1:38,000 (enlarged from 1:160,000	Transp.	2	1	2	2	1	2	3

NOTE: 1-Excellent; 2-Very Good; 3-Good; 4-Fair; 5-Poor

TABLE C.11.4. LAND USE CLASSIFICATION FROM CCRS 1:60,000 SCALE COLOUR-INFREARED PHOTOGRAPHY

CODE	LAND USE
1	URBAN AND BUILT-UP AREAS
11	RESIDENTIAL
11.1	Single-family dwelling
11.2	Multi-family dwelling
11.21	Townhouse (attached housing)
11.22	Apartment (low-rise)
11.23	Apartment (high-rise)
12	COMMERCIAL
12.1	Central business district
12.2	Suburban shopping centres
12.3	Residential commercial stores/ services
12.4	Commercial strip development
12.5	Automobile car-parks
13	INSTITUTIONAL: PUBLIC AND PRIVATE
13.1	Administrative buildings (city hall, fire dept., etc.)
13.2	Schools
13.3	Churches
13.4	Hospitals
13.5	Cemeteries
14	INDUSTRIAL
14.1	Extractive
14.2	Primary products manufacturing
14.3	Secondary products manufacturing
14.4	Non-manufacturing -- warehousing
14.5	Non-manufacturing -- open storage
15	RECREATIONAL: PRIVATE AND PUBLIC
15.1	Beaches
15.2	Parks
15.3	Golf courses
15.4	Arenas
15.5	Stadiums
15.6	Outdoor theatres
15.7	Racetracks
15.8	Athletic fields
16	TRANSPORTATION
16.1	Major freeway
16.11	Interchanges
16.2	Secondary highway
16.3	Road and street
16.4	Railroad right-of-way
16.41	Terminal
16.42	Yards
16.5	Marine terminal
16.6	Airport
17	COMMUNICATION
17.1	Telephone and telegraph communication
17.2	Radio and television communication
17.3	Gas, electric utility system
18	OPEN UNIMPROVED
18.1	Vacant lots (central core)
18.2	Idle land (urban fringe)
18.3	Swamp, marsh
18.4	Water

LAND USE CLASSIFICATION GROUP D

D.1: UNITED STATES STANDARD LAND USE CODING MANUAL CLASSIFICATION (primary system)

The Standard Land Use Coding Manual was first published in 1965 by the Urban Renewal Administration and the Bureau of Public Roads when the latter agency formed part of the United States Department of Commerce. Since its introduction the Standard Land Use Code (SLUC) has been widely used, either in its primary form or in systems derived from it. The system was developed "primarily for use in urban area planning. However, this sytem is sufficiently broad and flexible enough for use in studies of the urban--rural fringe and of rural areas" (U.S. Dep. Transportation, 1969). It appeared at a time when "much attention was being directed to urbanization and its impact on patterns of land use in the United States" (Anderson, 1971), and was published in the same year as Clawson and Stewart's Land Use Information (1965). Both publications benefited from exchanges of ideas between the committees which contributed to the volumes, and in Land Use Information considerable space is devoted to a discussion of the SLUC.

The SLUC study began with a review of more than fifty extant land use classification systems. This review contributed to a recognition "that different characteristics or dimensions that describe land should not be combined into a single classification system" if the system is to meet the needs of large and small communities alike (U.S. Dep. Transportation, 1969). This problem had been previously addressed by Shapiro (1959) who observed of many existing urban classification systems: "mingled together as 'urban land uses' are types of activities, types of establishments, types of structures, and legal rights - items that are anything but generally alike. Can they all be land uses?"

Rather than group into one category the many characteristics which may be used to describe a piece of land, the SLUC study concluded that each separate dimension or characteristic should be identified by a separate classification system. These characteristics might then be grouped after the fashion of building blocks, being "put together in the combinations that will best fit the needs of a particular planning study". The rapidly developing data processing and electronic computer fields in the 1960's lent themselves readily to this sort of approach.

> "Inasmuch as activity is considered to be the most important single land use classification for which comparability is desired, a system of categories identifying land use activities was developed. The primary purpose was to establish an extensive system of categories that would identify each land use activity and which could also be numerically coded in order to facilitate data handling on automatic data processing equipment. This, it was felt, would provide the beginning of a standard system of identification for one specific characteristic of land use" (U.S. Dep. Transportation, 1969).

The SLUC consists of 9 one-digit categories (two of which have been assigned to manufacturing, 67 two-digit categories, 294 three-digit categories, and 772 four-digit categories (Tables D.1.1 and D.1.2). The latter level of categories present land use activity in its greatest detail and as the system is aggregated to the one-digit level the information becomes more generalized. Auxiliary codes at the five-digit level permit activities to be even more fully described.

TABLE D.1.1. UNITED STATES STANDARD LAND USE CODING MANUAL CLASSIFICATION FIRST AND SECOND LEVELS

FIRST LEVEL CODE	CATEGORY	SECOND LEVEL CODE	CATEGORY
1	Residential	11	Household units
		12	Group quarters
		13	Residential hotels
		14	Mobile home parks or courts
		15	Transient lodgings
		19	Other residential, NEC*
2	Manufacturing	21	Food and kindred products - manufacturing
		22	Textile mill products - manufacturing
		23	Apparel and other finished products made from fabrics, leather, and similar materials - manufacturing
		24	Lumber and wood products (except furniture) - manufacturing
		25	Furniture and fixtures - manufacturing
		26	Paper and allied products - manufacturing
		27	Printing, publishing, and allied industries
		28	Chemicals and allied products - manufacturing
		29	Petroleum refining and related industries
3	Manufacturing (continued)	31	Rubber and miscellaneous plastic products - manufacturing
		32	Stone, clay, and glass products - manufacturing
		33	Primary metal industries
		34	Fabricated metal products - manufacturing
		35	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks - manufacturing
		39	Miscellaneous manufacturing, NEC
4	Transportation, communication, and utilities	41	Railroad, rapid rail transit, and street railway
		42	Motor vehicle transportation
		43	Aircraft transportation
		44	Marine craft transportation
		45	Highway and street right-of-way
		46	Automobile parking
		47	Communication
		48	Utilities
		49	Other transportation, communication, and utilities, NEC
5	Trade	51	Wholesale trade
		52	Retail trade - building materials, hardware and farm equipment
		53	Retail trade - general merchandise
		54	Retail trade - food
		55	Retail trade - automotive, marine craft, aircraft, and accessories
		56	Retail trade - apparel and accessories
		57	Retail trade - furniture, home furnishings, and equipment
		58	Retail trade - eating and drinking
		59	Other retail trade, NEC

TABLE D.1.1. (Continued)

FIRST LEVEL CODE	CATEGORY	SECOND LEVEL CODE	CATEGORY
6	Services	61	Finance, insurance, and real estate services
		62	Personal services
		63	Business services
		64	Repair services
		65	Professional services
		66	Contract construction services
		67	Governmental services
		68	Educational services
		69	Miscellaneous services
7	Cultural, entertainment, and recreational	71	Cultural activities and nature exhibitions
		72	Public assembly
		73	Amusements
		74	Recreational activities
		75	Resorts and group camps
		76	Parks
		79	Other cultural, entertainment, and recreational, NEC
8	Resource production and extraction	81	Agriculture
		82	Agricultural related activities
		83	Forestry activities and related services
		84	Fishing activities and related services
		85	Mining activities and related services
		89	Other resource production and extraction, NEC
9	Undeveloped land and water areas	91	Undeveloped and unused land area (excluding non-commercial forest development)
		92	Non-commercial forest development
		93	Water areas
		94	Vacant floor area
		95	Under construction
		99	Other undeveloped land and water areas, NEC

* NEC = Not elsewhere coded.

In Table D.1.2, the SLUC classification is shown to be accompanied by a "SIC Reference" column. The Standard Industrial Classification (SIC), a commonly used system for identifying economic activity, is

> "used in the classification of establishments by type of activity in which engaged; for purposes of facilitating the collection, tabulation, presentation, and analysis of data related to establishments; and for promoting uniformity and comparability in the presentation of statistical data ..." (U.S. Bureau of the Budget, 1957).

Because of the SIC's detailed classification of establishments and also because of the widespread acceptance of the nomenclature employed in the SIC, the SLUC system uses the SIC category titles and detailed identification of activities to the greatest extent possible.

> "However, no attempt was made to identify the four-digit land use categories by the same code numbers as the comparable categories in the SIC. It was not considered practical to make the numbers the same since establishments identified by separate code numbers under the SIC have in some instances been combined into one activity description in the four-digit land use codes. In other instances different types of establishments that were grouped under one code in

TABLE D.1.2. U.S. STANDARD LAND USE CODING MANUAL CLASSIFICATION RESIDENTIAL CATEGORY ONLY

SECOND LEVEL CODE	CATEGORY	THIRD LEVEL CODE	CATEGORY	FOURTH LEVEL CODE	CATEGORY	SIC REFERENCE
11	Household units	110	Household units	1100	Household units	-
12	Group quarters	121	Rooming and boarding houses	1210	Rooming and boarding houses	7021
		122	Membership lodgings	1221	Fraternity and sorority	Incl. 7041
				1229	Other membership lodgings, NEC*	Incl. 7041
		123	Residence halls or dormitories	1231	Nurses' homes	-
				1232	College dormitories	-
				1239	Other residence halls or dormitories, NEC	-
		124	Retirement homes and orphanages	1241	Retirement homes	-
				1242	Orphanages	-
		125	Religious quarters	1251	Convents	-
				1252	Monasteries	-
				1253	Rectories	-
				1259	Other religious quarters, NEC	-
		129	Other group quarters, NEC	1290	Other group quarters, NEC	-
13	Residential hotels	130	Residential hotels	1300	Residential hotels	Incl. 7011
14	Mobile home parks or courts	140	Mobile home parks or courts	1400	Mobile home parks or courts	7031
15	Transient lodgings	151	Hotels, tourist courts, and motels	1510	Hotels, tourist courts, and motels	7011
		159	Other transient lodgings, NEC	1590	Other transient lodgings* NEC	-
19	Other residential	190	Other residential, NEC	1900	Other residential, NEC	-

* NEC = Not elsewhere coded.

> the SIC may have been identified separately under the land use codes, differences, many land use activities that need to be identified for planning purposes are not comparable to any SIC industry description, and therefore, it would still have been necessary to establish new code numbers." (U.S. Dep. of Transportation, 1969).

Importantly, there are differences in interpretation of the word "establishment" in the SIC and the SLUC. In the former, "establishment" is defined as an "economic unit which produces goods or services - for example, a farm, a mine, a factory, a store. In most instances, the establishment is at a single physical location, and it is engaged in only one, or predominantly one type of economic activity for which an industry code is applicable." (U.S. Bureau of the Budget,

1957). On the other hand in respect of planning studies, land use activity is identified in terms of one of the following criteria and procedures:

1. through observation;
2. through interviews; or
3. through the use of secondary data sources such as insurance maps or assessors' records.

The SLUC Manual states that, in light of these differences of interpretation and in view of the fact that SLUC land use activities are not classified according to the value of the product or service, the same establishment might easily be identified differently under the two systems.

In addition to further details about SLUC contained in the Manual, the most authoritative contemporary commentary on this particular land use classification is provided by Clawson and Stewart (1965).

D.2: ALBERTA, DEPARTMENT OF MUNICIPAL AFFAIRS LAND USE CLASSIFICATION FOR TOWNS, VILLAGES, HAMLETS, AND SMALL CITIES

In 1978, J.C. Pearson and S. Verbisky of the Municipal Planning Section, Planning Services Division, Department of Municipal Affairs, prepared a preliminary land use classification system for smaller communities in Alberta (Pearson and Verbisky, 1978). This classification is derived from the SLUC system (D.1) and is shown in Table D.2.1.

The reader is directed to F.6 for additional information on land use classification in Alberta.

D.3: CITY OF HALIFAX LAND USE CLASSIFICATION

In January, 1977 the Planning Department of the City of Halifax issued its Land Use Coding and Classification Manual in a second edition. The introduction to the Manual notes that the "simplest and most flexible coding system applicable to the city of Halifax and Regional Urban conditions" is a substantially modified SLUC system (D.1) and an Activity-Based Land Use Classification related to that outlined in the National Building Code of Canada.

> "This coding classification system extracts the most desirable and applicable characteristics of both approaches and augments them with SIC M* classifications where appropriate. A unique system is produced that can be integrated with other geocoding and land registration data retrieval systems. Indeed, the system could be applied to any urbanized area in the Atlantic Provinces, where "fine grain" land and structure use information is required.
>
> "The recommended Activity-Based Land Use Coding/Classification System (ABLUCS) enables "families" of land uses to be handled conveniently in the various kinds of analyses necessary in the preparation and revision of the MDP component detailed local Area Plans. The proposed coding classification also permits rapid access to land use data and facilitates ready cross-referencing with other information bases." (Halifax, City of, 1977).

ABLUCS consists of 11 primary groups, about 70 secondary orders, and more than 460 tertiary or third level categories. The ABLUCS devised is sufficiently flexible at the third-digit level that auxillary codes for activities that are separate from, but organizationally linked to other activities, are unnecessary. Also, the tertiary codes may be expanced as necessary in the

*Statistics Canada, 1970. Standard Industrial Classification Manual. Ottawa.

TABLE D.2.1. ALBERTA, MUNICIPAL AFFAIRS PRELIMINARY LAND USE CLASSIFICATION GUIDE

CLASSIFICATION	LAND USE WITH CODE
A	RESIDENTIAL
1	Single Family (SF) - Single-family, mobile home on one lot (SF-MH) - Single-family, mobile home subdivision (SF-MHS)
2	Two-Family (2F) - Semi-detached (2F-SD) - Duplex (2F-D)
3	Multi-family (three-family and up) (MF) - Row housing (townhousing) (MF-RH) - Apartments (MF-Apts.)
4	Mobile home park (MHP) - if admit travel trailers, should be classed partly as Mobile Home Park, and partly as Commercial
5	Institutional residence (group quarters) (GR) - Senior citizens home (GR-SCH) - Youth hostel (GR-YH) - YMCA, YWCA - Boarding and rooming houses (GR-BH, RH) - Convents, monasteries (GR-C,M) - Halfway houses, etc. (GR-HH)
B	COMMERCIAL
1	Primary commercial (PC) - Light commercial, pedestrian-oriented, predominantly downtown uses - Not big space users - Examples: grocery stores, meat and dairy product stores, drugstores, news-stands, variety stores, barber and beauty shops, laundry and dry cleaning outlets, restaurants (other than drive-in), hardware stores, etc.
2	Secondary commercial (SC) - Larger space users - Commercial activities likely to create substantial traffic and parking problems, crowds, fire hazards, noise, etc. - Examples: automobile sales and service, drive-in eating and drinking establishments, gas stations, repair garages, commercial parking lots and garages, bars, beer parlours, theatres, skating rinks, miniature golf courses, bowling alleys, furneral establishments, veterinary establishments and animal boarding and hospital facilities; lumber, building materials and fuel dealers.
3	Hotels, motels, travel trailer parks (H)
4	Offices, studios, banks, etc. (OB)
C	INDUSTRIAL AND PUBLIC UTILITIES
1	Light industrial, warehousing, storage (LM) - Wholesaling, warehousing, storage and distribution activities involving substantial truck traffic - Relatively clean, quiet industrial uses - Emphasis on performance characteristics: uses included here are warehousing and industries which produce some noise, traffic congestion, or danger, but which are of such scale or character that they present no serious hazard to neighbouring premises from fire, smoke, noise, or odours. Certain large-scale industries can be included if they are clean and quiet enough and properly cushioned from residential areas.

TABLE D.2.1. (Continued)

CLASSIFICATION	LAND USE WITH CODE
C	INDUSTRIAL AND PUBLIC UTILITIES (Continued)
2	PUBLIC UTILITIES, except sewage treatment plants -- gas, electric, phone, radio, T.V., railway, airfield, sanitary landfill sites (nuisance grounds) (PM)
3	Heavy industrial and sewage treatments plants (HM) - Activities with relatively strong nuisance characteristics or high hazard factors (classification does not depend on size of products handled)
D	PUBLIC/INSTITUTIONAL
1	Educational institutions (SC-Pu Public) (SC-Sp Separate) (SC-PR Private)
2	Auditoriums and similar cultural facilities, civic organizations, etc. (PC)
3	Public administration facilities, office buildings (PA)
4	Medical and related facilities (MD)
5	Correctional and protective facilities (PJ)
6	Religious facilities (Ch)
7	Cemeteries (CE)
8	Historic sites (HS)
E	RECREATION/OPEN SPACE
1	Parks and open recreational areas (PK) - Public (PPK) - Quasi-public (QPO) - areas owned and/or operated by private individuals or groups for a public purpose (e.g., privately owned golf course)
2	Indoor recreational facilities (public or quasi-public) (IRF)
3	Cemeteries (CE)
4	Historic sites (HS)
F	AGRICULTURAL
1	Crop and pasture (AG)
2	Forest, woodland (W)
G	VACANT LAND (VL) - describe in each instance what is meant by "vacant"
H	WATERBODY (H2O)

Manufacturing and Commerce categories by augmenting with SIC# sub-category codes. The primary groups are:

0 Agriculture, Forestry, Fisheries, and Open Country

1 Extractive Industries, Spoiled Land, and Land for Disposal of Waste

2 Manufacturing Industry

3 Commerce; Including Retail, Wholesale, Service and Non-Manufacturing Industry, Offices, Storage

4 Residential

5 Civic, Cultural and Other Special Community Uses

6 Education

7 Open Spaces

8 Transportation

9 Public Utilities

T Temporary Activities

D.4: OAK RIDGE LAND USE CLASSIFICATION

The Oak Ridge ORRMIS Data Classification System is derived from the United States SLUC system (D.1) (Tomlinson et al., 1976). The four-level classification is shown in Table D.4.1.

D.5: SASKATCHEWAN DEPARTMENT OF MUNICIPAL AFFAIRS LAND USE CLASSIFICATION

The Municipal Lands Branch of Saskatchewan's Department of Municipal Affairs in 1978 issued a Discussion Paper on Land Use Surveys and Land Use Classification in that province (Wilson, 1978). The author noted that recently the Lands Branch had begun to compile a survey of Saskatchewan communities that included population and consumption of land use categories. The author also stated that "out of nearly sixty major reports compiled by numerous agencies and consultants less than six were found to contain comparable data on land use". The classification scheme ultimately selected as the basis for Saskatchewan is the SLUC system.

> "The activities are largely based on the Standard Industrial Classification (SIC) and as such are biased towards economic categories. This drawback is fully recognized but since the SIC is widely used and understood, the land use classification built on it becomes comparable with a variety of existing information ..." (Wilson, 1978).

The one and two-digit categories of the system are shown in Table D.5.1.

TABLE D.4.1. OAK RIDGE LAND USE CLASSIFICATION

4-LEVEL CODE	LAND USE
1	Constructed surfaces
11	Structures
111	Residential
1111	Household dwelling unit
1112	Group quarters
1113	Residential hotels
1114	Mobile home parks
1115	Transient lodgings
1119	Other
112	Manufacturing
1121	Food and kindred products
1122	Textile mill products
1123	Apparel and other finished products made from fabrics, leather and similar materials
1124	Lumber and wood products
1125	Furniture and fixtures
1126	Paper and allied products
1127	Printing, publishing and allied industries
1128	Chemicals and allied products
1129	Petroleum refining and related industries
1131	Rubber and plastic products
1132	Stone, clay and glass products
1133	Primary metal industries
1134	Fabricated metal products
1135	Professional, scientific and controlling instruments, etc.
1139	Miscellaneous manufacturing
115	Trade
1151	Wholesale trade
1152	Retail trade - building materials, hardware and farm equipment
1153	Retail trade - general merchandise
1154	Retail trade - food
1155	Retail trade - automotive, marine craft, aircraft and accessories
1156	Retail trade - apparel and accessories
1157	Retail trade - furniture, home furnishings and equipment
1158	Retail trade - eating and drinking
1159	Other retail trade
116	Services
1161	Finance, insurance & real estate
1162	Personal services
1163	Business services
1164	Repair services
1166	Contract construction services
1167	Government services
1168	Educational services
1169	Miscellaneous services
117	Recreation & cultural entertainment
1171	Cultural activities and nature exhibitions
1172	Public assembly
1173	Amusements
1174	Recreation activities
1175	Resorts and group camps
1176	Parks
1179	Other cultural entertainment and recreational activities
118	Resource related
1181	Agricultural
1182	Energy producer
1183	Flood control and water related
1189	Other resource related
12	Transportation and utility
121	Transportation
1211	Railroad, rapid rail transit and street rail, transport'n
1212	Motor vehicle transportation
1213	Aircraft transportation
1214	Marine craft transportation
1215	Highway and street right-of-way
1216	Automobile parking
122	Communications
1221	Communications
123	Utilities
1231	Resource (power) utilities
1232	Public service utilities
1233	Public facilities or government service
1234	Other
13	Resource Extraction
131	Surface mining or extraction (in active production)
1311	Metal ore mining
1312	Extraction of fuels
1313	Mining and quarrying of non-metallic minerals
132	Subsurface mining and extraction
1321	Metal ore mining
1322	Extraction of fuels
1323	Mining and quarrying of non-metallic minerals
133	Mining related
1331	Mining activities and related services
1332	Other resource extraction
2	Cultivated plants
21	Tillage crops
211	Irrigated row crops
2111	Grain crops
2112	Fibre crops
2113	Root crops
2114	Leaf and stem crops
2115	Annual fruit

TABLE D.4.1. (Continued)

4-LEVEL CODE	LAND USE
2	Cultivated plants (cont'd)
21	Tillage crops (cont'd)
211	Irrigated row crops (cont'd)
2119	Other
212	Non-irrigated row crops (same subdivisions as 2111-2119)
213	Irrigated close grown
2131	Small grains
2132	Fibre crops
2133	Other
214	Non-irrigated close grown (same subdivisions as 2131-2133)
215	Fallow
22	Nonwoody perennial
221	Turf
2211	Sod production
2212	Lawns
2213	Golf courses
2214	Parks
2215	Cemeteries
2219	Other
222	Irrigated hay crops
2221	Legume dominated
2222	Legume-grass mixture
2223	Grass dominated
2224	Other
223	Non-irrigated hay crops (same subdivisions as 2221-2224)
224	Untended grasslands
2241	Infrequently mowed
2242	Infrequently grazed
23	Woody perennial crops
231	Irrigated horticultural plantings
2311	Citrus fruits
2312	Noncitrus tree fruits
2313	Tree nut crops
2314	Vine crops
2315	Nursery and ornamental
2316	Berry crops
2317	Tropical fruits and nuts
232	Non-irrigated horticultural plantings (same subdivisions as 2311-2317)
233	Evergreen tree plantations
2331	Lumber or pulp
2332	Windbreak or planted hedgerows
2333	Christmas tree plantation
234	Deciduous tree plantation
2341	Lumber or pulp
2342	Sap and extractive
2343	Windbreak or planted hedgerow
3	Noncultivated herbaceous
31	Tall grases and grasslike plants
311	Pioneer wet
312	Pioneer mesic
313	Pioneer dry
314	Moderately stable wet
315	Moderately stable mesic
316	Moderately stable dry
317	Stable wet
318	Stable mesic
319	Stable dry
32	Tall forbs (same subdivisions as 311-319)
33	Medium-height grasses and grasslike plants (same subdivisions as 311-319)
34	Medium-height forbs (same subdivisions as 311-319)
35	Short grasses and grasslike plants (same subdivisions as 311-319)
36	Short forbs (same subdivisions as 311-319)
37	Dwarf plants (same subdivisions as 311-319)
4	Sclerophyll and shrub
41	Short evergreen
411	Pioneer wet
419	Stable dry
42	Midtall evergreen (same subdivisions as 411-419)
43	Tall evergreen (same subdivisions as 411-419)
44	Short deciduous (same subdivisions as 411-419)
45	Midtall deciduous (same subdivisions as 411-419)
46	Tall deciduous (same subdivisions as 411-419)
5	Woodland
51	Young evergreen
511	Wet
512	Wet mesic
513	Mesic
514	Dry mesic
515	Dry
52	Medium-age evergreen (same subdivisions as 511-515)
53	Mature evergreen (same subdivisions as 511-515)
54	Young deciduous (same subdivisions as 511-515)
55	Medium-age deciduous (same subdivisions as 511-515)
56	Mature deciduous (same subdivisions as 511-515)
6	Barren
61	Massive rock surfaces
611	Basic igneous and metamorphic
612	Acidic igneous and metamorphic
613	Limestone
614	Sandstone
615	Shale
62	Boulders and large rock fragments (same subdivisions as 611-615)
63	Gravel and rock fragments (same subdivisions as 611-615)
64	Sand
	641-649 (dominant primary mineral)
65	Fine soil
	651-659 (dominant secondary mineral)

TABLE D.4.1. (Continued)

4-LEVEL CODE	LAND USE
7	Inland waters
71	Turbid hard-water lakes and reservoirs
711	No aquatic vegetation
712	Floating unicellular plants
713	Floating multicellular plants
714	Submerged rooted plants
715	Emergent rooted plants
72	Clear hard-water lakes and reservoirs (same subdivisions as 711-715)
73	Turbid soft-water lakes and reservoirs (same subdivisions as 711-715)
74	Clear soft-water lakes and reservoirs (same subdivisions as 711-715)
75	Turbid hard streams and rivers (same subdivisions as 711-715)
76	Clear hard streams and rivers (same subdivisions as 711-715)
77	Turbid soft streams and rivers (same subdivisions as 711-715)
78	Clear soft streams and rivers (same subdivisions as 711-715)
8	Tidal waters
81	Shallow, turbid ocean water
811	No aquatic vegetation
812	Floating unicellular plants
813	Floating multicellular plants
814	Submerged rooted plants
815	Emergent rooted plants
82	Shallow clear ocean water (same subdivisions as 811-815)
83	Deep turbid (same subdivisions as 811-815)
84	Deep clear (same subdivisions as 811-815)
85	Brackish turbid estuaries, bays and sounds (same subdivisions as 811-815)
86	Brackish clear (same subdivisions as 811-815)
87	Saline turbid (same subdivisions as 811-815)
88	Saline clear
9	Other

TABLE D.5.1. SASKATCHEWAN DEPARTMENT OF MUNICIPAL AFFAIRS LAND USE CLASSIFICATION

LEVEL I CODE	LEVEL I LAND USE	LEVEL II CODE	LEVEL II LAND USE
A10	Residential	A11	Permanent residential
		A12	Temporary residential
A20	Manufacturing	A21	Food and kindred products
		A22	Textiles
		A23	Apparel (fabrics, leather, etc.)
		A24	Lumber and wood products (excluding furniture)
		A25	Furniture and fixtures
		A26	Paper and allied products
		A27	Printing and publishing
		A28	Chemicals and allied products
		A29	Petroleum refining and related industries

TABLE D.5.1. (Continued)

LEVEL I CODE	LEVEL I LAND USE	LEVEL II CODE	LEVEL II LAND USE
A30	Manufacturing (cont'd)	A31	Rubber and miscellaneous plastics
		A32	Stone, clay and glass products
		A33	Primary metal industries
		A34	Fabricated metal products
		A35	Instruments (control, scientific, photographic, optical, chronometric, etc.)
		A39	Miscellaneous manufacturing, NEC*
A40	Transportation, communication and utilities	A41	Railroad, rapid rail transit and street railway transportation
		A42	Motor vehicle transportation
		A43	Aircraft transportation
		A44	Marine craft transportation
		A45	Highway and street right-of-way
		A46	Automobile parking
		A47	Communication
		A48	Utilities
		A49	Other transportation, communication or utilities, NEC
A50	Trade	A51	Wholesale trade
		A52	Building materials, hardware and farm equipment (retail)
		A53	General merchandise (retail)
		A54	Food (retail)
		A55	Automotive, marine craft, aircraft and accessories
		A56	Apparel and accessories
		A57	Home furnishing and equipment
		A58	Eating and drinking
		A59	Other retail trade, NEC
A60	Services	A61	Finance, insurance and real estate
		A62	Personal services
		A63	Business services
		A64	Repair services
		A65	Professional services
		A66	Contract construction services
		A67	Government services
		A68	Education
		A69	Miscellaneous services, NEC
A70	Cultural, entertainment and recreation	A71	Cultural activities and nature exhibition
		A72	Public assembly
		A73	Amusements
		A74	Recreational activity
		A75	Resort and group camps
		A76	Parks

TABLE D.5.1. (Continued)

LEVEL I CODE	LEVEL I LAND USE	LEVEL II CODE	LEVEL II LAND USE
A70	- Cultural, entertainment and recreation (cont'd)	A77	- Designated conservation and preservation areas
		A79	- Other cultural, entertainment or recreation, NEC
A80	- Resource production and extraction	A81	- Agriculture
		A82	- Agriculture related activities
		A83	- Forestry and related activities
		A84	- Fishing and related activities
		A85	- Mining and related activities
		A89	- Other resource production, NEC
A90	- Undeveloped land and water	A91	- No perceived activity
		A92	- Non-reserve forests (undeveloped)
		A93	- Water areas
		A94	- Vacant floor area
		A95	- Under construction
		A99	- Other undeveloped land, NEC

* NEC = Not elsewhere coded.

LAND USE CLASSIFICATION GROUP E

E.1: ONTARIO LAND USE CLASSIFICATION (primary system)

"In classifying land uses, it might be more realistic to identify the processes occurring on land, or as they are translated into modifications of the land itself. In other words, a truly comprehensive land data system should try to classify man through his activities on the land. Land use, then, needs constantly to be related to the more encompassing land information system of which it is part." (Ont. Min. Treasury, Economics, and Intergov. Affairs, 1974).

The Ontario Land Use Classification, Activity and Structure was published by that province's Local Planning Policy Branch, Ministry of Treasury, Economics and Inter governmental Affairs in 1974. The classification was developed from an approach suggested by the Land Use Study Advisory Committee, Town Planning Institute of Canada (Hodge and McCabe, 1968). The primary purpose of the project was to design a classification which would cover all signficant land uses and which would serve the widest possible number of planners and other potential users. The classification had two additional requirements: impartiality, whereby it covered both urban and rural land uses; and hierarchy, whereby it permitted inventory at varying levels of detail and enabled ordered aggregation of data.

The authors of the classification state that:

"Generally... land use can be said to describe the process by which land as a resource is modified through the spatial interaction of man and land. Physical assets, since they are incapable of providing a product or a service, possess no real land use significance."

The process of interaction is derived from:

1. modification of human action occurring on a spatial unit (space-behavioural);
2. change in the location of actions from one unit to another (space- locational);
3. changes in use-potential of a unit due to changes in space resource (space-developmental);
4. adjustments in mode of linkages between units (channel-behavioural);
5. changes in patterns of location of linkage arteries (channel-locational); and
6. improvements in capacity of arteries for whatever mode is desired (channel-developmental).

These processes document land use in relation to two fundamental perspectives: those which act upon or respond to the physical environment (behavioural and locational); and those which result in physical improvement upon the land (developmental). This distinction is translated into concepts of structure and activity as "observable behaviourable, locational, and developmental adjustments". The relationships between the structure and the activity are identified as function, whereby function defines operational units as dominant, complementary, and/or dependent relationships.

In the process of comprehending the community and allocating land among competing developmental and locational possibilities, the planner must consider the following principal elements:

1. structures -- the development and adaptation of buildings, constructions and improvements;
2. activities -- human actions perceived by improvements or modifications to the land resource unit;
3. functions -- interactions and linkages between structures and activities on land use parcels that relate to adjacent and surrounding parcels; and
4. impact or effect -- a land use description which identifies constraints to the type or quality of land use on surrounding land units arising from specific types of land uses.

Certain technical requirements for an operational Ontario land use classification were recognized:

1. comprehensiveness -- the classification should provide a framework for including each and every possible land use;
2. purity -- it should develop a single pure criterion for differentiation of sub-classes within each class;
3. flexibility -- it should permit various combinations of descriptive series to obtain the required analytical classes;
4. electronic data processing -- the classification was designed with the capability of producing large volumes of data, thus, to facilitate the recording, storing, retrieving, and analyzing of data, the adaptability of the system to technology was considered; and
5. implementation and updating -- the classification is open enough to accommodate new data and classes according to implementation and updating requirements.

The classification process employed in this particular system has been developed by applying definitions and criteria to each level of the land use classification. Originally a fourfold series of land use classification had been conceived (i.e., Structure, Activity, Function, Effect), but only two tangible series, structure and activity, were eventually pursued. Constraints of cost, availability of data, and institutional frameworks for data collection were given little weight in the theoretical portion of the study. The

structure code and the activity code are shown in Tables E.1.1 and E.1.2 respectively.

The structure series describes the buildings, the structures, and the artificial improvements on the land. The report states:

> "The primary concern is with building and structure types and not with the use to which these structures may be put. Obviously, certain activities or operations (say, farming or manufacturing) determine the structure, design, and layout of buildings (in this case, barns and factories).
>
> "Similarly, certain architectural forms have been associated with certain activities such as churches, law courts, schools, and hospitals. Yet this is increasingly less true today as more building types are becoming multi-purpose and easily adaptable to specific needs.
>
> "This gives rise to problems in grouping structures and activities by type. The designation of the main two-digit classes such as Dwelling Type, Building Type, etc., indicates not the activity pursued in the building or on the structure, but design considerations. In other words, a particular building's structure conforms to the requirements of a particular activity which may or may not be conducted in or on it." (Ont. Min. Treasury, Economics and Intergov. Affairs, 1974).

With respect to activity (see Table E.1.2), two points are made. First, activity describes the actual observable use of land and, therefore, land as an index of value or social status will have no activity connotation. Secondly, activity is significant only in identifying a man to land relationship. That is, activity is man in the process of using land by adapting it, by changing its natural form, or by causing it to yield a product.

In sum, the Ontario land use classification consists of two separate but parallel descriptive series. Each is open and capable of further local expansion (other parallel information systems such as the Standard Industrial Code could be useful to the activity system). Nevertheless, the system cannot be regarded as a comprehensive planning information system.

Electronic or manual data processing is possible with the system. And varying levels of map documentation with two-, three- and four-level codes are possible for municipal mapping and plans. Colour codes may be applied at the second level. These codes, supplemented by symbols and alphabetic codes, may be attempted at the third level, and the fourth level would serve as a numerically coded map display system.

Two sets of occupancy codes are recommended to supply planners, housing specialists, and others with information on tenure and ownership (Table E.1.3).

TABLE E.1.1. ONTARIO LAND USE CLASSIFICATION STRUCTURE CODE

DEFINITION	CODE	CLASS
S - Structure	S0	No construction or improvement
	S1	Improved area
A description of varieties of structure types, including buildings, constructions, and improvements located over, on, or under the land as physical alterations	S2	Structure type
	S3	Multi-structure type
	S4	Building type
	S5	Dwelling type
	S7	Converted structure
	S8	Under construction
	S9	Other
S0	S0	No construction or improvement
S1	S11	Dredged
	S12	Reclaimed/drained
	S13	Irrigated
	S14	Landscaped
	S15	Cultivated/cropped
	S16	Excavated
	S17	Filled
	S18	Mounded
	S19	Surfaced
S2	S21	Enclosure
	S22	Container
	S23	Containment
	S24	Shelter
	S25	Support structure
	S26	Connecting structure
	S27	Free-standing structure
	S28	Line, rail, road
	S29	Other
S3	S3	Multi-structure
S4	S41	Assembly
	S42	Office/shop
	S43	Warehouse/factory
	S44	Shelter/container
	S45	Combination building
	S49	Other
S5	S51	Single-dwelling unit (detached)
	S52	Two-dwelling unit (semi-detached)
	S53	Duplex
	S54	Other plexes
	S55	Attached row
	S56	Apartment
	S59	Other (including hotel, motel, lodges, rooming houses, etc.)
S7	S71	Converted to dwelling
	S72	Converted to assembly
	S73	Converted to office/shop
	S74	Converted to warehouse/factory
	S75	Converted to shelter/container
S8	S81	Construction in progress
	S82	Demolition in progress
	S83	Incomplete/abandoned structure

TABLE E.1.2. ONTARIO LAND USE CLASSIFICATION ACTIVITY CODE

1-DIGIT CLASSIFICATION	2-DIGIT CLASSIFICATION	3-DIGIT CLASSIFICATION
0 - No Perceived Activity	00 - No Perceived Activity	000 - No Perceived Activity
1 - Residential	11 - Private Residential	111 - Principle Private Residential
		112 - Seasonal Private Residential
	12 - Collective Residential	121 - Principle Collective Residential
		122 - Seasonal Collective Residential
2 - Resource Production	21 - Farming	211 - Tree Crops
		212 - Vine Crops
		213 - Crops
		214 - Livestock
		219 - Other
	22 - Forestry	221 - Logging
		222 - Tree Production
		223 - Field Nursery
		229 - Other
	23 - Fish and Wildlife Production	231 - Fish Hatcheries
		232 - Fish Runs and Ladders
		233 - Wildlife Breeding Stations
		234 - Wildlife Habitat
		239 - Other
	29 - Other	
3 - Resource Extraction	31 - Shaft Mining	311 - Metallic Ore Extraction
		312 - Non-metallic Ore Extraction
	32 - Pumping	321 - Water
		322 - Gaseous Fossil Fuel
		323 - Liquid Fossil Fuel
		324 - Soluble Mineral
		329 - Other
	33 - Open Pit Mining and Quarrying	331 - Metallic Ore Extraction
		332 - Fossil Fuel Extraction
		333 - Rock Extraction
		334 - Gravel Extraction
		335 - Sand Extraction
		339 - Other
4 - Manufacturing	41 - Energy Conversion	411 - Wind Propelled
		412 - Solar
		413 - Hydro Electric
		414 - Fossil Fuel
		415 - Nuclear
		419 - Other
	42 - Raw Material Processing	421 - Water Purification
		422 - Food Processing
		423 - Natural Fibres and Pelt Processing

TABLE E.1.2. (Continued)

1-DIGIT CLASSIFICATION	2-DIGIT CLASSIFICATION	3- DIGIT CLASSIFICATION
4 - Manufacturing (cont'd)	42 - Raw Material Processing (cont'd)	424 - Rock and Stone Processing
		425 - Clay Processing
		426 - Ore Processing
		427 - Petroleum Processing and Refining
		428 - Processing of Chemicals
		429 - Other
	43 - Processed Goods Processing	431 - Food
		432 - Textiles
		433 - Woodworking and Wood Products
		434 - Structural Materials
		435 - Metal and Metal Products
		436 - Petroleum Products
		437 - Chemical Products
		439 - Other
	44 - Products Assembly	441 - Clothing and Textiles
		442 - Building Components, Furniture and Fixtures predominantly of wood
		443 - Containers, Structural Component Furniture, Fixtures and Fittings, predominantly of metal
		444 - Scientific Equipment and Precision Instruments
		445 - Machinery and Mechanical Equipment including Hardware
		446 - General Equipment, including Household Appliances
		447 - Chemical Products
		448 - Automobiles and Automotive Products
		449 - Other
	45 - Waste Treatment	451 - Liquid Waste
		452 - Solid Waste
		453 - Gaseous Waste
		459 - Other
5 - Terminal and Storage	51 - Terminal	511 - Bus Terminal
		512 - Rail Terminal
		513 - Dock, Wharf
		514 - Airport
		515 - Broadcasting and Communication
		516 - Power Transmission and Control Station
		517 - Pipeline Pumping and Control Station
		519 - Other

TABLE E.1.2. (Continued)

1-DIGIT CLASSIFICATION	2-DIGIT CLASSIFICATION	3-DIGIT CLASSIFICATION
	52 - Storage	521 - Open-Air Storage
		522 - Warehousing
		523 - Reservoir and Tank Storage
		524 - Docking and Berthing
		525 - Open-Air Parking
		526 - Parking Garage and Hangar
6 - Transportation and Communication	61 - Transportation Movement	611 - Road Traffic
		612 - Railway Traffic
		613 - Air Traffic (along reserved runway approaches)
		614 - Water Traffic (through portages and canals)
		615 - Pipeline Transportation
		619 - Other
	62 - Communication and Energy Conductor System	621 - Power Transmission System
		622 - Telegraph System
		623 - Telephone System
		629 - Other
7 - Shopping, Repair and Servicing	71 - Retail Shopping	711 - Food Retailing
		712 - Clothing Retailing
		713 - Furniture, Hardware and Appliance Retailing
		714 - Automotive Products, Sales and Showrooms
		715 - Variety Store Retailing
		716 - Department Store Retailing
		717 - Specialty Store Retailing
		718 - Shopping Centre
		719 - Other
	72 - Repairing and Servicing Consumer Commodities	721 - Clothing and Textiles
		722 - Furniture, Hardware and Household Appliances
		723 - Automobile Service and Repair
		729 - Other
	73 - Personal Services	731 - Refreshment and Entertainment
		732 - Cosmetic Service
		739 - Other
	74 - Business Plant and Equipment Sales and Servicing	741 - Sales and Servicing Equipmnt
		742 - General Maintenance
		749 - Other

TABLE E.1.3. ONTARIO LAND USE CLASSIFICATION TENURE AND OWNERSHIP OCCUPANCY CODES

OCCUPANCY TYPE	OCCUPANCY STATUS	CODE
	TENURE	
Building	Owner occupied	1
Building	Tenant occupied	2
Building	Vacant	3
Building	Under construction	4
Land only	Used by owner	5
Land only	Used by tenant	6
Land only	Not in use - vacant	7
Neither Building nor land, e.g. Bell Telephone Wire		8
	OWNERSHIP	
Private (Residential and non-residential)		1
Private Residential - Publicly assisted*		2
Private Residential on Leased Land = H.O.M.E. Units		3
Condominium		4
Co-operative		5
Public (Residential** and non-residential)		6

*Limited Dividend, Rental Assistance (where known), etc.
**Limited Dividend and other Public Housing

E. 2: ONTARIO URBAN AND REGIONAL TRANSPORTATION PLANNING OFFICE CLASSIFICATION SYSTEM

In May 1978, the Urban and Regional Transportation Planning Office, Ontario Ministry of Transportation and Communications reported that the Regional Information Systems Committee (RISC), a joint Regional Municipality and Provincial body responsible for developing land use information monitoring systems, had prepared a land use classification system based on the Ontario Land Use Classification (E.1). The proposed system was then undergoing final changes before being implemented in south-central Ontario.

LAND USE CLASSIFICATION GROUP F

F.1: ONTARIO HIGHWAY ENGINEERING DIVISION SURVEYS AND PLANS OFFICE LAND USE CLASSIFICATION

In 1977, the Remote Sensing Section of the Surveys and Plans Office, Highway Engineering Division, Ministry of Transportation and Communications reported* in its procedures for the preparation of land use studies:

*L.Tam, Highway Eng. Div. Surveys and Plans Office: personal communication.

1. the land use classification is established in consultation with the requestor. In many cases the classification is limited by the available photography;

2. land use categories are differentiated and boundaries are delineated by remote sensing (photo interpretation) techniques, supplemented by selective field checks; and

3. depending on the size of the study area, photographic enlargements or mosaics are used as a base for recording the information. Annotation occurs on the base and a legend is provided.

Table F.1.1 shows the complete land use classification which is employed in the agency's studies.

TABLE F.1.1. ONTARIO HIGHWAY ENGINEERING DIVISION SURVEYS AND PLANS OFFICE LAND USE CLASSIFICATION

CODE	LAND USE
1.	RESIDENTIAL - existing and under construction
Rh	High Density Residential - areas where individual lots occupy less than 1/8 acre.
	Rh-i - Individual Houses
	Rh-h - High Rise Apartments
	Rh-l - Low Rise Apartments
	Rh-r - Row Housing
	Rh-t - Trailer Parks
RM	Medium Density Residential - areas where individual lots occupy from 1/8 acre to 1/2 acre.
Rl	Low Density Residential - lot size greater than 1/2 acre but where individual houses are close enough to be grouped conveniently. Includes strip and estate residences.
R	Individual Residences - where houses are too widely separated to be grouped under Rl.
2.	COMMERCIAL
C.B.D.	Central Business District (downtown)
Cc	Shopping Centre, Mall, or Plaza
Cs	Strip Development - areas are usually a line of businesses along one or both sides of a roadway. Restaurants, service stations, motels, offices, truck yards, etc.
C	Individual Businesses - isolated and not easily grouped.
3.	INSTITUTIONAL
Ich	Churches
Ic	Cemeteries
Is	Schools
Ih	Hospitals
Ig	Government - All Levels - Jails, Arenas, Armories, Power Plants, Sanitary Landfill, etc.
4.	TRANSPORTATION
Ta	Airports, Public, Private, and Float Plane Facilities
Tr	Railway Lines and Yards
Tl	Transmission Lines - oil, gas, or hydro as noted
5.	INDUSTRIAL
Ie	Extractive - Sand, Gravel, Clay, Stone, or Mineral

TABLE F.1.1. (Continued)

CODE	LAND USE
Ip	Processing - Reworking of raw material by mechanical, heat, or chemical processes to produce materials from which goods can be made - oil refinery, steel mills, sawmills brick plants, etc.
Ihf	Heavy Fabrication - Plants utilizing products from processing industries that require heavy-lifting equipment to produce large and heavy products.
Ilf	Light Fabrication - Plants utilizing products from processing industries that do not require heavy-lifting equipment and whose products are not extremely heavy or rarely very bulky.
6. AGRICULTURAL	
AV & O	Vineyards and Orchards
As	Specialty Farms - Market Gardening, Sod, Tobacco, Poultry, Fur, etc.
AM	Mixed - Beef or Dairy operation includes cropland, improved pasture and fallow
At	Tilled Fields
7. RECREATIONAL	
Rpu	Public - Parks, Beaches, Conservation Areas
Rpr	Private - Golf Courses, Ski Clubs, plus money-making ventures, miniature golf resorts, etc.
Rc	Cottages - Private shoreline development
8. OPEN SPACE	
Ow	Woodland - Greater than 50% tree cover at any stage of development
Orf	Reforested Land - Reforested land at any stage of development
Op	Permanent Pasture or abandoned land - Impossible to include in crop rotation cycle due to physical and topographic problems, land with rock or sand outcrops
Os	Swamps or marshes

F.2: GREATER VANCOUVER REGIONAL DISTRICT LAND USE CLASSIFICATION

Prepared by the Land Use Working Committee of the Greater Vancouver Regional District (GVRD) (1974), the classification was designed to be utilized during annual revisions of GVRD land use maps (Table F.2.1). In each update (for the period June 1 to May 31), new subdivisions and development are to be added to the maps (using building or occupancy permits) and development which no longer exists is to be crossed out. Assessment roles are to be checked to determine changes in the use of existing structures.

Except in instances where there is a special basic class which reveals a land use mixture (e.g., Mixed Residential and Office), only one use should be coded on any one property. Where more than one land use exists, only the predominant use is to be coded.

Each year, once map updating has been completed by each municipality, the corrected maps are forwarded to the GVRD where the original sepias are updated. Once updating has taken place, new, up-to-date maps are forwarded to the municipalities.

TABLE F.2.1. GREATER VANCOUVER REGIONAL DISTRICT LAND USE CLASSIFICATION

CATEGORY	LAND USE
I	Residential
	A. Single Family
	B. Duplex
	C. Conversion
	D. Apartment
	E. Cluster Housing
	F. Mobile Home Park
	G. Institutional Residence
	H. Mixed Residential and Retail
	I. Mixed Residential and Office
II	Social and Public Services
III	Commercial
	A. Office
	B. Retail and Personal Service
	C. Retail and Office Mixed
	D. Hotels and Motels
IV	Inventory
	A. Manufacturing
	1. Food processing
	2. Wood products
	3. Metal products
	4. Chemical and petroleum products
	5. Stone, glass, and clay products
	6. Textile manufacturing
	7. Other industries
	B. Extractive
V	Wholesaling and Storage
	A. Wholesaling and Warehousing
	B. Open Storage
VI	Transportation and Transportation Facilities
VII	Utilities
VIII	Communications
IX	Recreation
	A. Outdoor Recreation
	B. Indoor Recreation
X	Agriculture and Forestry
XI	Cemetery
XII	Vacant

F.3: NEW YORK STATE LAND USE AND NATURAL RESOURCES INVENTORY

The Land Use and Natural Resources Inventory (LUNR) is the computerized record of an aerial survey of New York's land resources. It is supported by some retrieval, analysis, and display computer programs specifically developed for the inventory. The system contains 130 categories of land use data and four categories of supplemental data for the entire state (Hardy, 1975; Shelton and Hardy, 1968; and Swanson, 1969).

> "LUNR was undertaken because of a general feeling in state government that a consistent inventory of the state's natural resources was needed, rather than because it was required to achieve any specific objectives. In 1966, Governor Rockefeller stated that a natural resources inventory would be conducted. The State Office of Planning Coordination was assigned that task and decided to obtain information on land use as well as natural resources, for its own purposes. The system thus originated to fulfil some unidentified needs felt to exist in the state rather than for a specific purpose." (Tomlinson et al., 1976).

LUNR illustrates a set of practical, inexpensive techniques for conducting and using large-scale environmental inventories. The techniques fall into two main categories, "Inventory Techniques" and "The Data System". The former include classification of information to be acquired, data acquisition procedures, and the production of map products of the inventory. The data system consists of the computer-based techniques for going beyond the mapped products to quantitative summary and analysis. The data system may be established without complete (or any) data input and with only slight dependence on the exact inventory techniques. Likewise the inventory techniques do not

require any special equipment or base maps because existing topographic or planimetric maps may be used. Data acquisition may be satisfactorily achieved through ground survey and air-photo interpretation.

Black-and-white aerial photography was selected as the principle method of inventorying on the basis of cost, availability, and general usefulness. In 1968, almost the entire state (50,000 square miles) was flown at 1:24,000 to correspond with the United States Geological Survey 7.5-minute quadrangles. The remaining, secondary data was obtained in the course of field checking.

The LUNR classification system (shown in Table F.3.1) consists of ten major categories and 51 second-level (area) and 68 third-level (point) subcategories. The data storage format allows space for an additional 200 data items per cell beyond the 130 categories already included.

> "Area categories and subcategories are coded as a combination of capital and small letters, except for outdoor recreation where a numeral follows the designation 'OR', and public and semi-public where a capital letter is followed by a numeral. Point (and linear) categories are coded as small letters only or as small letters followed by numerals or non-numerical signs. Symbols consisting of small letters and non-numerical signs indicate that the data have been stored as a numerical count or total length per cell. Letters with numerals indicate only that this category is present in a particular cell... These symbols were used as the mapping codes during interpretation and overlay preparation and are used to identify categories desired for computer retrieval and analysis ....
>
> "A grid system with 1 km² (0.4 sq. mile) cells was developed and related to the USGS quadrangles. This cell size was recognized as being too gross for urban planning, but it was nevertheless selected because rural areas were the main subjects of the study. About 140,000 cells were required to cover the entire state. Three types of overlays were produced for each quadrangle....
>
> 1." Area land use overlay - Polygons of particular uses were outlined and areas estimated by placing a hectare grid over each cell and counting the number of hectare cells in which a particular use predominated. These counts where then used to estimate percentages of land uses for each cell... Both land uses (human) and natural resource characteristics (for example, natural lakes, forest land) were noted, but only one characteristic was assigned to a particular polygon. The smallest unit recognized during interpretation was 0.4 ha (1 ac)...
>
> 2." Point land use overlay - This consists of both point or small-area features such as underground mining or campgrounds, and linear features such as roads or streams. Point features were tallied by category. Total lengths of streams were measured and likewise tallied. Many were traced on the overlay but some were not...
>
> 3." Compilation overlay - This would show minor civil divisions such as township lines, county lines, villages, and it would carry road classifications. The length (miles) of each within a cell would be recorded. 'Our practice was to record the length of roads, streams, and shorelines in a cell'..." (Tomlinson et al., 1976).

The LUNR system required 2 years of work and cost in excess of $750,000 ($4 per km² or $10 per sq. mile).

The system is considered to be readily exportable to other geographic areas. One such example is the land use inventory, classification, and recording system developed by the Black River — St. Lawrence Regional Planning Board (1972). This system varied from the LUNR system in that the number of categories were reduced in the former and the grid cell size was reduced to 1/4 km².

TABLE F.3.1. LUNR LAND USE CLASSIFICATION SYSTEM

CATEGORY	LAND USE
A	AGRICULTURE
	Agricultural land use is classified first as active (in commercial use) or inactive (fairly recently removed from agriculture).
	Active areas are delineated according to use by major enterprises - orchards; vineyards; horticulture; cropland intensively used for cash crops; and land used more extensively for crops related to dairy and also poultry, pasture and specialty farms. Each includes headquarters areas.
	Inactive classifications include land fairly recently removed from active agriculture but not yet committed to forest regeneration, and also land waiting to be developed or under construction for urban uses.
	The classification was developed for the complex agriculture of the Northeast. In other regions, wide diversity may be less common and larger parcels may be devoted to one use.
ACTIVE AREAS	
	Agricultural lands with observable evidence of use; includes headquarters areas.
Ao -	Orchards: Intensively managed commercial orchards.
	Old orchards, which do not show signs of active operation, are classified in a lower category or intensity class, usually Forest Brushland Fc if old trees remain.
	Commercial orchard operations are point counted at the headquarters location as f.
Av -	Vineyards: Intensively managed commercial vineyards.
	Abandoned vineyards are usually classified as Forest Brushland Fc.
	Headquarters of vineyard operations are point counted as f.
Ah -	Horticulture or floriculture; sod and seed farms; nurseries: Commercial operations. These enterprises, especially nurseries, often include greenhouses.
	Nurseries with less than two acres of growing area are not considered commercial. Operations only for holding and selling nursery products are considered sales businesses Cs.
	Headquarters of Ah operations are point counted as f.
At -	High intensity cropland: Areas of intensive production of vegetables (fresh and processed market vegetables) small fruits (berries), potatoes and other truck crops.
	All muckland developed commercially is classified in this category.
	Headquarters are point counted as f.
Ac -	Cropland and cropland pasture: Areas used for growing cultivated field crops, forage crops, grain, dry beans, etc.
	Rotated pastures may be included here, particularly if aftermath grazing is practised.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE

ACTIVE AREAS (Continued)

If this land use is associated with dairy farming, the headquarters is point counted as d, and if associated with poultry, as e. If it is associated with neither but is used with an active farm whose major enterprise is listed above (Ao, Av, Ah, At) or is simply in general farming, the headquarters is point counted as f.

Ap - Pasture: Usually permanent or unrotated pasture areas.

Some areas may show scattered brush, but with evidence of grazing or cow trails, they are still classified as Ap rather than Forest Brushland Fc.

Ay - Specialty farms: All areas are delineated as Ay and point data are mapped separately in the following categories:

y-1 Mink farms: Active commercial mink operations with housing, storage, feeding and waste disposal facilities and practices evident. When these are combined with other farming, the enterprise that appears to be the principal one is identified.

y-2 Pheasant or game farm: These may be publicly or privately owned. They may use surrounding farm buildings and fields to grow grain for the birds on the farm. Sometimes the farms are in conjunction with private shooting areas (OR-13), which may be mapped separately.

y-4 Duck farm: Specialized, intensive operations found only on Long Island.

Many are vertically integrated, centering egg production, hatching, growing, processing and marketing (of eggs, meat, fertilizer, etc.) in what may resemble an industrial operation.

Ponds and fenced-in areas indicate the bird-raising part of the farm.

y-5 Aquatic agriculture: Commercial fishing areas, including oyster beds and trout and bait operations.

Upstate these usually appear as a series of contiguous ponds separated by dikes.

Commercial sport fishing businesses may raise the sport fish on the premises.

Shell fish enterprises are only in coastal areas.

y-6 Horse farms: Only commercial operations for raising, boarding, breeding and training riding, race or sulky horses and ponies.

Does not include rural residences or farms with one or a few horses or ponies for private use.

AGRICULTURAL ENTERPRISES

Point data, associated with area data but mapped separately:

d - Number of dairy operations: Commercial dairy operations, as indicated by buildings, use of land, marketing facilities (milk-houses with milking parlours) and waste disposal facilities.

It is not always possible to distinguish full-time or part-time commercial dairy operations.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE

AGRICULTURAL ENTERPRISES (Continued)

The point location is indicated at the headquarters buildings.

Milk bottling and processing facilities are not included unless they are part of a dairy farm operation.

e - Number of poultry operations, including turkeys and ducks: Only commercial poultry operations are considered, after secondary (supplemental) information ascertains that these are active and generally full-time operations.

They may be remodeled dairy barns or in new structures designed for poultry, but in each case, feed storage facilities, waste disposal and ventilation help to verify the secondary information.

These are point counted at the location of the headquarters.

f - Number of active farm facilities: Includes all farming not classified as d or e or y. Farming activity indicators and agricultural land use must be visible in the area.

Includes farms with principal intensive enterprises of orchards Ao, vineyards Av, horticulture and floriculture Ah, and intensive cropland At, as well as beef and stock farms and general farming of a lower intensity.

INACTIVE AREAS

Agricultural areas with no indication of active agricultural use.

Ai - Inactive agricultural land: Identifies unused agricultural land that has not yet developed brush cover Fc but is probably committed toward that category. This is one of the most difficult land uses to identify. It is sometimes impossible to differentiate between this type of land use and land diverted from active use in a government program, which may come back to active agricultural use after a diversion program of one or more years. The entire area around the particular field or section must be studied for any abandoned farm buildings or a developing residential or commercial area.

Ui - Urban inactive: Areas tending toward urban intensive uses, usually commercial, residential or industrial. Again the surrounding land uses are a guide. If the area is completely surrounded by commercial, industrial or residential uses, it is without question classified as Ui. If active or inactive agricultural land or forest land uses occur on the periphery of residential, commercial or industrial land, they retain their identity and are not classified as Ui.

Uc - Under construction: Previously inactive or agricultural land being developed for active non-agricultural use. Roads may be laid out and obvious construction underway, without visual evidence to show whether the site will be used for commercial, residential, public or industrial development.

F

FOREST LAND

Land use areas in forestry follow agricultural classifications in the progression from intensive use for crops to inactive land to mature forests - forest brush cover and stands of maturing forests, respectively. The classification also includes artificially stocked plantations, usually, but not necessarily, conifers.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE
F	FOREST LAND (Continued)
	Fc - Forest brushland, generally areas where forests are regenerating, with more than 10 percent brush cover, up to and including pole stands (6" in diameter) less than 30' in height and 40 to 50 years of age. This is often land formerly cleared for agriculture, or older forested areas that have been clear-cut, heavily grazed or completely burned over.
	Fn - Forest lands: Land areas with natural stands where 50 percent or more of the trees are over 50 years old and over 30' high.
	Fp - Plantations: Areas artificially stocked, of any species, age, class or size.
W	WATER RESOURCES
	Water resources information includes mapping of water and wetland areas, a count of farm ponds and other water bodies, and a measure of miles of shorline of lakes, rivers and streams.
LAKES AND PONDS	
	Wn - Natural ponds and lakes: Natural water bodies with an area of more than one acre, not ones constructed by interrupting a natural water course.
	n - (point data) - Number of Wn, counted only at the outlet of the water body.
	Wc - Artificial ponds, lakes and constructed reservoirs: Bodies with a water area of more than one acre, defined by obvious water level control structures.
	c - (point data) - Number of Wc, counted at the control structure.
	p - (point data) - Number of ponds, defined as any body of water of less than one acre.
	l@ - (point data) - Lake shoreline: Total miles, in tenths, of all water bodies delineated as Wn and Wc.
STREAMS AND RIVERS	
	Ws - Streams and rivers: Area delineation includes only segments of streams averaging 100 feet wide, but if a stream generally above this width is constricted over a short distance, that section is also mapped as Ws. If a stream, whatever its width, is impounded, the area is mapped as Wc and the structure counted as c.
	s@ - (point data) - Stream and River Mileage: Total miles in tenths, of all streams and rivers, regardless of width but excluding obvious drainage ditches.
WETLANDS	
	The numerous types of wetlands are summarized in three groups:
	Wb - Marshes, shrub wetlands and bogs: Ranging from waterlogged areas with no standing water to areas with a maximum of three feet of water and vegetation predominatly of shrub size or smaller.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE

WETLANDS (Continued)

Ww - Wooded wetlands: Areas covered with varying depths of water for much of the year, with vegetation mainly of trees.

Wk - Marine (salt) wetlands: For Long Island the five boroughs of New York City, wetland areas adjacent to and influenced by salt water. Includes tidal flats, waterlogged areas and areas of standing water with marsh grass and shrub vegetation.

MARINE LAKES, RIVERS, AND SEAS

Wm - Areas in embayments and sounds, between the shore and state boundaries, which lie in marine waters - areas in the Great Lakes, St. Lawrence River, Long Island Sound and the Atlantic Ocean.

c@ - (point data) - Coastline: Total miles, in tenths, of coastline (Long Island Sound and Atlantic Ocean only).

d@ - (point data) - Developed coastline: Miles, in tenths, of developed coast other than that in Rk (cottages).

HUDSON RIVER

Wh - Uncontrolled section of the Hudson River from New York City or the mouth of the Mohawk River and the federal dam at Troy.

R

RESIDENTIAL LAND USE

Residential land use is based on a housing density gradation from single farm residences to high density urban housing, noting apartment buildings, rural hamlets, and areas of vacation homes and cottages (only along lakes, rivers and other water bodies and courses).

Distinction is first made between farmsteads f and rural non-farms residences 0 or x, generally fewer than four per 1,000 feet of road. Areas with four or more non-farm residences per 1,000 feet of highway frontage are referred to as strip develop Rs.

As housing density increases, and a street or subdivision pattern occurs, lot size, measured in lot frontage, becomes the key factor.

RESIDENTIAL AREAS

These are the areas more than 95 per cent in housing.

Rh - High density: Lot frontage less than 50 feet, usually in older urban areas and in mobile home parks.

Rm - Medium density: Lot frontage between 50 and 100 feet.

Rl - Low density: Lot frontage greater than 100 feet.

Rs - Strip development: Four or more non-farm residences per 1,000 feet of highway frontage, usually in predominantly open country or in a single line along an existing through road.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE

RESIDENTIAL AREAS (Continued)

Rr - Rural hamlet: Any community with a population under 1,000 in the 1960 Census but with visible community development. Besides residences, there usually are a few commercial establishments and/or public buildings, focusing on a crossroads or road intersection.

Rc - Farm labour camp: Usually barrack-type camps to house migrant or seasonal labourers, associated with agricultural areas of high-intensity crops. Secondary information is used to verify the few found with lumber operations.

Re - Rural estate: Residences with developed lot sizes of more than five acres, including the home, lawns, gardens, fenced areas, roadways and shrubbed area but not undeveloped wood growth.

When a farm operation, with additional houses, is associated with the estate, the main residence is included in Re and the farm is indicated as a regular farm operation, with the most logical additional house considered the farm headquarters.

COTTAGES AND VACATION HOMES

These are only areas along or adjacent to lakes, rivers or other water bodies. The residential structures are used predominantly for vacation homes; year-round homes are seldom included.

Rk - Shoreline development: Areas of residential structures, usually extending back one parcel from the shoreline.

k@ - (point data) - Miles, measured in tenths, of shoreline with access limited by cottage development.

APARTMENT BUILDINGS

These are complexes or developments of multi-family housing units. They are mapped as high density residential areas Rh but are differentiated by point counting from other Rh areas containing single, duplex and other private dwellings.

Z - (point data) - Apartment buildings: Presence in cell indicated by some number between 1 and 99.

MOBILE HOMES

Mobile homes in parks (more than three mobile homes at one location) are mapped as high density residential areas Rh.

v - (point data) - Number of mobile home parks in one square kilometre cell.

#m - (point data) - Number of mobile homes in each park.

#* - (point data) - Number of mobile homes not in a housing density area.

#▲ - (point data) - Number of mobile homes within a housing density but not in a mobile home park.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE

RURAL NON-FARM RESIDENCES

Fewer than four residences per 1,000 feet of road frontage which are neither the headquarters for an active farmstead nor a part of a residential strip Rs nor of a residential density. A tenant house on a farm may be indicated as a rural non-farm residence.

x - (point data) - Rural non-farm residences: Number of residences built for non-farm residential purposes (never used as a farm headquarters) in a one square kilometre cell.

0 - (point data - Rural non-farm residences: The number in a cell of residences previously used as farm headquarters but now used as rural non-farm residences.

C and I — COMMERCIAL AND INDUSTRIAL LAND USES

Rather broad categories of land use were necessary because of the complex mixture and large number of types of commercial and industrial land uses in some areas. In most cases, the composition of individual types of commercial and industrial land use can be inferred or assumed from these broad categories. However, to accurately define and identify such areas in detail would require larger-scale photography than was used in this project.

As a state-wide inventory of an area whose greatest proportion is open-land uses, the detail of the standard urban area land use inventory could not be justified - because much urban information is available elsewhere and because the inventory had other purposes. Such information could be added at any time with larger-scale photographs, additional secondary and field information and variable (smaller) cell sizes for data storage and retrieval.

COMMERCIAL AREAS

Areas predominantly connected with the sale of products and services.

Cu - Central business sections of cities and villages: Residential and other commercial and industrial areas are generally around these areas and focused upon them.

Cc - Shopping centres: Outlying areas of commercial activity, usually more integrated than developments in the urban centre areas.

Cr - Resorts: Commercial resorts which range in size from converted farmhouses to luxury resort hotels, featuring associated outdoor recreation such as swimming pools, tennis courts, small golf courses, small ski-slopes, riding stables. Full-size outdoor recreation facilities possibly associated, such as golf courses or ski slopes, are mapped as OR.

Cs - Strip development: Commercial activities along a major highway or city or village street. Behind and mixed with such areas may be residential, agricultural, industrial or inactive areas. Individual commercial businesses may also be shown this way.

INDUSTRIAL AREAS

Areas devoted to product manufacturing and research are mapped in two basic categories:

TABLE F.3.1. (Continued)

CATEGORY	LAND USE

INDUSTRIAL AREAS (Continued)

I1 - Light manufacturing and industrial parks: Light manufacturing processes, storage, shipping and industrial administration and research, including parking lots to serve these installations and warehouses. These industries may be thought of as "clean" - for designing, assembling, finishing and packaging products rather than for processing basic or heavy raw materials.

Ih - Heavy manufacturing: Fabricating from basic materials - such as steel mills, oil refineries, chemical plants, paper mills, lumber mills, etc. Includes storage areas for raw, processed and waste materials and transportation facilities to handle heavy materials.

OR

OUTDOOR RECREATION LAND USE

While other extensive areas of private and public lands and waters are used for outdoor recreation - including hunting, fishing, hiking and sight-seeing - this category includes activities for which specific areas have been developed and which constitute the predominant use of land. The classification conforms in general to the outdoor recreation inventories of the U.S. Soil Conservation Services. (Note that the following listing of OR categories does not use all numbers.)

OR - Outdoor recreation: All areas where this activity is the predominant land use are identified as OR. For specific types, on the point count, OR is followed by a number.

OR-1 - Golf courses: Golf courses of all sizes, including adjacent country-club-like facilities.

OR-2 - Ski areas and other winter sports such as tobogganing, sledding and ice skating: May include trails for skiing and snowmobiling, along with club and warming houses and parking areas, checked through supplemental information.

OR-3 - Swimming pools and developed beaches: Public and commercial, open to the public, including parking facilities. Does not include backyard private pools, or pools on the grounds of resorts, country clubs, etc.

OR-4 - Marinas, yacht clubs and boat-launching sites: Includes parking areas. Supplemental information is used for verification.

OR-5 - Campgrounds, public and private: Includes organizational camps and various combinations of commercial tent and travel trailer sites. They are checked against supplemental information.

OR-6 - Stadiums, race tracks, amusement parks, drive-in theatres, go-cart racing: Includes all facilities connected with these enterprises. Supplemental information is used when necessary.

OR-8 - Fairgrounds: County and state fairgrounds, usually easily identifiable.

OR-9 - Public parks: City, town and state park areas designed for extensive use only. Includes trails, picnic areas and wooded areas for hiking. Intensively developed areas such as swimming pools, golf courses, ski areas, marinas, etc., are indicated separately in the point data under the appropriate OR number. Supplemental information is used to verify these.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE
OR	OUTDOOR RECREATION LAND USE (Continued)
	OR-13 - Rifle and skeet shooting; Includes firing lines and bunkers, as well as associated clubhouses and parking areas.
	OR-16 - Other private and community recreational facilities. All recreational facilities not included in the numbered OR items - for example, neighborhood baseball diamonds and playing fields. Supplemental information is used to locate and verify ones difficult to identify on aerial photos.
E	EXTRACTIVE INDUSTRY LAND USE
	The various types of surface and sub-surface mining operations are delineated separately. Open mining areas, such as stone quarries and sand and gravel pits which contain water are treated as water bodies only if it is evident that the area is no longer used for extractive purposes. If access is possible, they can be considered as any other natural or artificial lake or pond. Supplemental information is often necessary for identifying underground extractive activities.
OPEN MINING	
	Surface material extraction.
	Es - Stone quarries: Includes crushed stone and dimension stone operations.
	Eg - Sand and gravel pits: Evidence of active use is necessary.
	Em - Other mining, such as iron, talc, emery, garnet, limestone for cement and clay.
UNDERGROUND MINING	
	Sub-surface material extraction.
	Eu - Underground mining: Areas are all identified as Eu, with specific types point counted.
P	PUBLIC AND SEMI-PUBLIC LAND USES
	In other categories ownership is not considered. The general focus is on type and intensity of activity, or the nature and extent of resources which comprise a land use. In this category, ownership could be considered the basis for classification, but this is not entirely the case, for the particular character of the activities is important.
	These activities are almost exclusively oriented toward providing services to the public, by public and private bodies. Because ownership by public or semi-public groups could not be observed directly, this category is strongly backed by supplemental information. (Note that in the following P categories not all numbers are used in sequence.)
	Transportation land uses have been made a separate category, although they could logically have been considered here.
	P - Public and semi-public land use: Areas mapped as P; types identified for the point count by P followed by a number.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE

P — PUBLIC AND SEMI-PUBLIC LAND USES (Continued)

P-1 - Educational institutions of all levels: Schools, colleges, universities, training centres, etc. They may be publicly or privately owned.

P-2 - Religious institutions: Churches, monasteries, etc. Some retreats and religious camps are classified here if they do not fall into the corresponding OR category.

P-3 - Health institutions: Hospitals, mental institutions, major clinics, sanitariums and others, but not nursing homes.

P-4 - Military bases, depots and armories, including Reserve and National Guard armories.

P-5 - Solid waste disposal: Includes auto junkyards (20 or more junk cars or pieces of equipment), sanitary landfills and exposed dumps. Abandoned gravel pits are frequently used as dumps.

P-6 - Cemeteries: Public and private.

P-7 - Water supply treatment facilities.

P-8 - Sewage treatment plants, including surrounding areas.

P-9 - Flood control facilities: Levees, dikes, dams.

P-11 - Correctional institutions: Prisons, prison farms, rehabilitation centres, etc. Does not include city and county jails where prisoners are held temporarily.

P-12 - Road and street equipment centres for city, village, township, county and state.

P-16 - Welfare centres, county homes and farms. Some agricultural activity is associated with the farms, although not usually in New York State. Land associated with such institutions, if publicly owned and used for commercial farming, is classfied as regular farmland.

P-17 - State Office Building Campus, Albany, and the United Nations, New York City.

P-18 - Plum Island Animal Disease Research Center.

P-19 - Groundwater recharge areas: Mapped only on Long Island, these are basins used to collect surface water run-off. These are usually only a few acres in area, but quite numerous in some parts of Long Island. They are 15 to 20 feet deep, are fenced and have an equipment roadway to the interior base, with run-off collectors evident.

T — TRANSPORTATION LAND USES

The types of transportation recorded in this inventory are intended to indicate the degree of access possible to each square kilometre cell, a factor which affects its present and potential use. Also, many land use boundaries are determined by transportation lines.

This category includes communications and utilities. Long-distance transmission of fuel, electricity or water is not always a predominant use of the land it passes through, but it does affect the present and potential uses of adjacent areas and is a significant transportation feature. Communication facilities fall logically in this category, even though they do not transport material products.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE

HIGHWAYS

Th - Total area of interchanges, limited access right-of-ways, service and terminal facilities, and other areas connected with highway use.

h - (point data) - Highest category within each cell: This is intended to indicate the highest degree of access.

h-0 - None (no highway).

h-3 - Unimproved, gravel and minor paved roads: Generally township roads.

h-4 - Two-lane and three-lane highways.

h-5 - Four-lane highway.

h-6 - Divided highway, usually four lanes with access and a dividing strip or mall.

h-7 - Limited access highway.

h-8 - Limited access highway interchange.

RAILWAY

Tr - Total area of facilities.

r - (point data) - Type of facility, identified by number.

r-1 Abandoned right-of-way.

r-2 Active track.

r-3 Switching yards.

r-4 Stations and structures.

r-5 Spur.

AIRPORT

Ta - Total use of facilities.

a - (point data) - Type of facility, identified by number (confirmed by reference to state and federal aviation maps).

a-1 Personal airport (including flying farmer).

a-2 Non-commercial.

a-3 Commercial, fixed base operator: Charter flights, etc.

a-4 Scheduled airline.

a-5 Military airport.

a-6 Heliport.

a-7 Seaplane base.

TABLE F.3.1. (Continued)

CATEGORY	LAND USE

BARGE CANAL

Tb - Total area of facilities: New York State Barge Canal System and inactive systems.

b - (point data) - Type of facility, identified by number.

b-1 Channel.

b-2 Lock.

b-3 Inactive or abandoned channel.

MARINE SHIPPING (Ocean, Great Lakes, Seaway)

Tp - Areas of port or dock facilities, including those extending over water.

Ts - Areas of shipyards and dry docks.

Tl - Areas of locks and water control structures.

COMMUNICATIONS AND UTILITIES

Tt - Total area of facilities. Including pumping stations, electrical substations, etc.

t - (point data) - Types of facility designated with a number as follows:

t-1 TV-radio tower.

t-2 Microwave station.

t-3 Gas and oil (long-distance transmission pipeline).

t-4 Electric power and telephone (long-distance transmission line).

t-5 Water (long-distance transmission lines).

N — NONPRODUCTIVE LAND

This category includes only areas without any observable present use that would place them in one of the preceding categories. They do not support economic vegetation, although scrub brush is possible in Nr areas. Extreme natural conditions restrict potential uses.

Ns - Sand: Areas with unstable, exposed sand predominant on the surface. Vegetative cover never existed or has been destroyed. Includes undeveloped beaches, but not sand which has been stabilized by grass culture or tree planing, which is classified by the existing land use or type of cover.

Nr - Exposed rock cliff, rock slopes and slide areas: Little or no vegetation is apparent. Includes such areas as the Hudson River Palisades and rock faces of mountains.

F.4: MINNESOTA LAND USE CLASSIFICATION

In response to repeated calls in the United States for both state and national land use plans, the State of Minnesota in its Perspective on Minnesota Land Use - 1974, displayed a detailed land use plan (Borchert et al., 1974; see also Orning and Maki, 1972). The map contains nine major classes of land distributed among 1.5 million forty-acre parcels in the state.

The land use of each forty-acre parcel is defined "as the socio-economic function which is served by the greater part of the parcel. To perform its function, a forty may be either 'developed' or 'preserved'". The forty-acre parcels, in turn, have been simplified into areal units known as Minor Civil Divisions (organized rural towns or incorporated municipalities). Each Minor Civil Division (MCD) is classified according to the Land Use Combination contained within it. Every MCD contains a mixture of different land uses dominating its component forty-acre parcels. (A rural township typically contains 576 forties.)

When these mixes are analyzed and grouped for the state as a whole, 18 distinctive Land Use Combinations emerge (Table F.4.1). Each of these combinations has its particular landscapes which reflect the combined influence of man and nature. This arrangement provides a basis for dividing the state into three broad regions (Cultivation, Transition, Forest) and many subregions, on which are superimposed concentric zones of urban influence.

F.5: NATIONAL LAND USE CLASSIFICATION UNITED KINGDOM

In the United Kingdom, as elsewhere, the absence of a standard method of classification has impeded both the potential value of land use plans and the utility of the data from which plans are derived and administrative decisions reached. "This lack", observe the authors of National Land Use Classification, "has led to similar land uses being given different names and similar names being applied to different land uses". When reviewing the work and practices of local authorities, the authors of the report examined 21 classification systems currently in use. There were great differences in the methods employed, many classifications being tailored to the needs and resources of individual authorities with little regard to whether the classification was compatible with other systems. Until such inconsistencies are surmounted, "few plans or studies can be inter-related unless prepared by the same body, even though they may be intended to serve common purposes". (Scottish Development Dep. and Dep. Environment, 1975).

The National Land Use Classification and an earlier, companion volume, General Information System for Planning (GSIP), (HMSO, 1972), represent an endeavour to outline the structure of a comprehensive information system for each level of plan drawn up by central and local government authorities, and to develop a land use classification which will serve the various purposes of planning and will also have regard to the needs of other users of land use data.

TABLE F.4.1. MINNESOTA LAND USE COMBINATIONS

LAND USE COMBINATION	LAND USE DOMINANT ON GREATEST ACREAGE	LAND USES PRESENT IN HIGH PERCENTAGES COMPARED WITH STATE TOTAL	OTHER LAND USES PRESENT IN MODERATE PERCENTAGES COMPARED WITH STATE TOTALS	OTHER USES PRESENT ON SMALL BUT SIGNIFICANT ACREAGE	LANDSCAPE DESCRIPTION
Cultivated Zone					
1	Cultivation	Cultivation		Open, Extractive	Intensive Cultivation on prairie plains
2	Cultivation	Cultivation		Forest, Open, Extractive	Intensive cultivation with scattered woodlands
3	Cultivation	Cultivation	Open	Water, Marsh, Extractive, Open	Intensive cultivation with scattered pasture
4	Cultivation	Cultivation	Open	Forest, Marsh, Extractive	Intensive cultivation with scattered pasture and woodlands
Transition Zone					
5	Cultivation		Cultivated, Marsh, Open	Forest, Water, Extractive	Cultivation with pasture on rolling or rough land
6	Cultivation		Forest, Cultivated, Marsh, Open	Water, Urban, Extractive	Cultivation with pasture land woodland on poorly drained or rough areas
7	Cultivation	Water, Marsh	Forest, Cultivation	Open	Cultivation with water, forest, and pasture
8	Cultivation	Water	Forest, Cultivation, Marsh, Open	Urban	Cultivation with forest, pasture, and water; sparsely developed lakeshore
9	Cultivation	Water	Forest, Cultivation, Marsh, Urban, Open	Extractive	Cultivation with water, forest, and pasture; much developed lakeshore
Forest Zone					
10	Forest	Forest	Marsh	Cultivation, Water, Urban, Open	Forest
11	Forest	Forest, Water	Marsh	Open	Forest with lakeshore undeveloped
12	Forest	Forest, Water	Marsh	Urban, Open	Forest with sparsely developed lakeshore
13	Forest	Forest, Water	Urban	Marsh, Extractive, Open	Forest, with much developed lakeshore
14	Forest	Forest, Extractive	Water, Urban	Open, Cultivation	Forest, with extensive mining
15	Forest	Marsh	Forest, Open	Cultivation	Marsh and Forest
Urban Zone					
16	Urban	Urban	Open	Cultivation, Forest	Urban development with scattered farmlands and woods
17	Urban	Urban	Water	Open, Forest	Urban development with some lakeshore
18	Urban	Urban		Forest, Open, Cultivation	Dense Urban Development

Initial attempts at consistency in land use definition in the United Kingdom took place when two circulars were released by the Ministry of Town and Country Planning (1949 and 1951) (see, also A.2). Corresponding publications were issued by the Department of Health for Scotland. These broadsheets recommended standard land use notation for survey and development plan maps, but definitions of land use because they were not completely precise, were interpreted in different ways. Thus, the original problems of inconsistency and incompatibility persisted.

With the passage in 1968 of the Town and Country Planning Act and the introduction of a new style of development plan, the need for standard land use classification appeared even more pressing. "The sub-regional character of structure plans called for joint-working and close co-operation by adjoining planning authorities, and interchange between them of data on many subjects, including land use". Two study teams representing several central and local government agencies were formed and these produced the 1972 and 1975 reports cited above. In the case of the classification study team, approximately six years passed between its formation and the appearance of the National Land Use Classification. The considerable period of time required to produce the classification has been attributed to:

1. lack of general consensus among the 64 local authorities consulted on basic questions about the concept of a standard classification;

2. the length of time required for user trials of the initial proposals; and

3. the elaborate and detailed process of modification which proved necessary as the result of user trial reports and comments.

The classification has been designed to fit in with proposals contained in the General Information System for Planning report. The classification is compatible with these proposals in three main areas:

1. the treatment of activity as an attribute of land;

2. the spatial units to which data may be related; and

3. the method of locating the spatial units.

Three key questions were posed by the study team in seeking to determine a satisfactory approach to the land use classification. These were:

1. what meaning should be attributed to the term 'use', and how should uses be identified?

2. what should 'land' in the term "land use" include?

3. to what spatial unit area on areas should the classification relate?

There was little in the way of universal agreement in solutions to these questions among the local authorities approached by the study team, but there was common consent on two matters: a need definitely existed for a standard classification; and the classification should be hierarchical in structure. Following these consultations certain guidelines were drawn up for the

development of a land use classification system. These guidelines are summarized briefly.

1. Meaning of the term "use". Two approaches are recognized as most common for planning purposes. One equates use with "activity", i.e., man's activities on land, while the other describes use without conforming to firmly established rules. Those developing the classification system generally preferred a classification based on activity. Activity was viewed as providing a neutral theme which stood less chance of being distorted by having different meanings attributed to it. Other data (e.g., ownership or building form or intensity of use) could be attached as additional attributes without becoming a formal part of the classification structure. Those developing the classification were required to take account only of activities which required permanent facilities or had defined sites allocated to them or which occurred regularly or frequently at the same place.

2. Meaning of the term "land". Many surveys attribute a single use to a site without stating whether it is the use at ground level or a reflection of the main purpose of the development, taking all levels above and below ground into consideration. It was decided that uses at all levels should be recorded and classified, including those above and below ground and those on artificial surfaces on or above water, such as piers, jetties, or houseboats, provided these surfaces were extensions of the land. In instances where land or other surfaces accommodated more than one activity (e.g., agriculture and defence; agriculture, forestry and recreation; recreation and water storage), these situations should be treated as in the case of activities at different levels; that is, uses arising from independent activities at the same level should be recorded and classified separately.

3. Spatial units. In the General Information System for Planning report stress was placed upon the need to collect data for the smallest unit of area so as to provide the greatest flexibility and combination in use. The report's authors were cognizant of the fact that it is not possible to disaggregate below the smallest unit for which data have been collected and so they devised a unit which they described as follows:

"our analysis of information requirements for planning has shown that there are uses, e.g., large factory sites where it is desirable to split a hereditament into component activity or use areas. We have therefore conceived what we have termed Basic Spatial Units (BSU's). These planning data units (i.e. BSU's) are based on hereditaments (in the case of non-rated hereditament), or a subdivision of a hereditament the remaining part being one or more BSU's (i.e. leaving no voids.) Any non-rateable land in or around a built-up area which is being divided into BSU's should be made up into 'dummy' hereditaments (i.e. parcels equivalent to hereditaments, though un rated) so that no voids are left." (Scottish Development Dep. and Dep. Environment, 1975).

By a majority of those engaged in the classification exercise the BSU was adopted for classification purposes in urban areas. Unanimity was not reached because some perceived that the BSU would contribute to an over-detailed level of

working for the purposes of both general and land use data collection. Objections also were raised in terms of the amount of manpower and financial resources required for such detailed data gathering (e.g., Greater London Council).

4. Main activity. No difficulties were presented in delimiting the extent of a single use zone and identifying the activity to which classification should be related, but difficulties were encountered when BSU's were to be employed for subdividing sites which accommodate more than one activity. In such instances the classification was required to relate to "main activities" and the extent of uses arising from these activities would determine the areas of the BSU's.

"A main activity was taken as being either the only activity present, or the activity on which other activities depended and without which they would lose their purpose. Two examples will illustrate how this concept might be applied. If a site were given over wholly to the storage of goods, storage would be the main activity and the whole site would be defined as a BSU, provided that it was not larger than a hereditament. Another site on which the goods were manufactured might accommodate several activities additional to, but dependent on manufacturing, such as packaging, car and lorry parking and office work. In this case, unless the activities were physically separate and could be treated independently the main activity would be manufacturing and, as in the previous example, the whole site would be defined as a BSU. If, however, the activities were physically separate and they would each be identified as a main activity and the areas they occupied, together with any related activities, would be defined as separate BSU's. For example, the area taken up by car and lorry parking together with, say garage and vehicle cleaning, would be a BSU centred on the main activity of parking. The same principle would apply if part of the site accommodated an activity which was independent of manufacturing; that part of the site would be a separate BSU and uses consequent upon that activity would be classified separately."

5. Standard Industrial Classification. The National Land Use Classification has been related to The Standard Industrial Classification (SIC) issued by the Central Statistical Office. The latter classification is used in the collection, coding, and organization of certain data, mostly about the manufacturing industry. The government's Census of Production and Census of Distribution are prepared and presented in terms of categories of the SIC. Although the SIC is concerned with economic activities rather than land use it was found that the names of CIS Minimum List Headings in the manufacturing industry categories could be incorporated in the land use classification, sometimes in modified form.*

The National Land Use Classification, adopted after user trials and further consultation, consists of four levels of land use names ranging from the Order at the top down through Group and Sub-Group to Class. As in most hierarchical classifications the names in the Order level are very general (Table F.5.1) and become progressively more detailed at each successively lower level. There are 15 Orders, 78 Groups, 150 Sub-Groups, and more than 600 Classes. Names not directly

*See, for the purposes of comparison, the relationship of the U.S. Geological Survey Classification (C.1) to the U.S. Standard Land Use Coding Manual, itself derived from the U.S. Standard Industrial Classification.

TABLE F.5.1. ORDERS OF THE NATIONAL LAND USE CLASSIFICATION (U.K.)

ORDER	CODE
Agriculture and fisheries	AG
Community and health services	CM
Defence	DF
Education	ED
Recreation and leisure	LE
Manufacturing	MA
Mineral extraction	MI
Offices	OF
Residences	RS
Retail distribution and servicing	RT
Storage	ST
Transport tracks and places	TR
Utility service	UT
Wholesale distribution	WH
Unused land, water and buildings	UL

related to activity usually have been excluded except for the descriptive terms in the Residential, Transport and Unused Land, Water and Buildings Orders. Part of the classification is shown on Table F.5.2 for illustrative purposes.

An Index also has been prepared. It contains about 2,500 land use names arranged alphabetically and indicates the appropriate categories for them in the classification system. These names are taken from three main source classifications currently in use by authorities; the SIC; and the classification system itself. To ensure consistency with the classification system descriptive terms are provided for different types of dwelling and transport facility and for unused land, water, and buildings. Entries are referenced to codes of Class names except where they are too general for the fineness of the Class categories. In such cases, they are referenced to codes in higher levels of the system.

Three types of spatial units may be employed with that classification: (1) the basic Spatial Unit (BSU), (2) the Hereditament, and (3) the Zone.

1) Basic Spatial Units

The BSU is the smallest unit for which activity data are recorded. In built-up areas the BSU often coincides with the Hereditament. A BSU may be expected to take one of the following forms:

a) an area of open land with no buildings on it;

b) an area of land partially covered by buildings where the outside space is used in close association with the internal space, for example, a house and a garden;

c) a complete building or range of interconnected buildings with no open land around them;

d) part of a building consisting of a single complete floor, or two or more complete (or part) floors at different levels;

e) a space forming part of a transportation route;

f) a water space enclosed by land or a man-made boundary.

The report states that:

"When the BSU is to be employed and it is found that parts of a site (which may be a hereditament) accommodate different main activities, the site should be subdivided and the subdivisions recognized as separate BSU's each BSU being defined by uses consequent on a main activity and its dependent

TABLE F.5.2. PART OF THE NATIONAL LAND USE CLASSIFICATION (U.K.) AGRICULTURE AND FISHERIES (AG) AND MANUFACTURING (MA)

LAND USE NAME	ORDER	GROUP	SUBGROUP	CLASS
AGRICULTURE AND FISHERIES	AG			
Animal service places	AG	01		
Animal service places	AG	01	A	
Animal artificial insemination				-A
Animal dipping				-B
Blacksmith premises				-C
Animal welfare places	AG	01	B	
Animal boarding				-A
Animal clipping and manicure				-B
Animal quarantine				-C
Veterinary hospital				-D
Veterinary surgery				-E
Animal living places	AG	02		
Animal breeding places	AG	02	A	
Fish farm				-A
Hatchery				-B
Paturition				-C
Service pen				-D
Animal rearing places	AG	02	B	
Bedding and waste removal				-A
Feeding				-B
Isolation				-C
Rearing pond				-D
Weighing				-E
Animal product processing places	AG	03		
Animal milking places	AG	03	A	
Milk extraction				-A
Milk treatment				-B
Animal shearing places	AG	03	B	
Wool grading				-A
Wool removal				-B
Animal slaughtering places	AG	03	C	
Animal stunning and killing				-A
Knackering				-B
Processing				-C
Packing places	AG	03	D	
Egg grading				-A
Fish sorting				-B
Feed handling places	AG	03	E	
Feed preparation				-A
Feed storage				-B
Animal product waste handling places	AG	03	F	
Animal product waste storage				-A
Animal product waste treatment				-B
Wildlife capturing places	AG	04		
Fishery places	AG	04	A	
Net				-A
Pot and other inshore or estuarial				-B
Rod and line				-C

TABLE F.5.2. (Continued)

LAND USE NAME	ORDER	GROUP	SUBGROUP	CLASS
AGRICULTURE AND FISHERIES (cont'd)	AG			
Agricultural research	AG	05		
Agricultural research establishments	AG	05	A	
Agricultural research				-A
Cultivated places	AG	06		
Arable farm places	AG	06	A	
Cereal crops				-A
Fallow				-B
Green forage crops				-C
Pulse crops				-D
Root crops				-E
Horticultural places	AG	06	B	
Allotment garden				-A
Flower garden				-B
Glass house				-C
Hop field				-D
Mixed market garden				-E
Nursery				-F
Orchard with arable land				-G
Orchard with grass				-H
Orchard with market garden				-I
Soft fruit				-J
Vegetable field				-K
Crop processing places	AG	07		
Crop conditioning grading and storage places	AG	07	A	
Cereal crops				-A
Fruit crops				-B
Green forage crops				-C
Pulse crops				-D
Root crops				-E
Mill and mix building				-F
Packing and sorting				-G
Vegetable				-H
Non-cultivated places	AG	08		
Grazing places	AG	08	A	
Permanent pasture				-A
Rough grazing				-B
Forestry places	AG	08	B	
Coniferous forest				-A
Coppice				-B
Coppice with standards				-C
Deciduous forest				-D
Mixed forest				-E
Tree nursery				-F
MANUFACTURING	MA			
Coal, oil and metal processing places	MA	01		
Coal and petroleum processing places	MA	01	A	
Coke ovens and solid fuel manufacturing				-A
Lubricating oil and grease manufacturing				-B
Mineral oil refinery				-C

TABLE F.5.2. (Continued)

LAND USE NAME	ORDER	GROUP	SUBGROUP	CLASS
MANUFACTURING (cont'd)	MA			
Metal processing places (basic forms)	MA	01	B	
Aluminium and aluminium alloy manufacturing				-A
Copper, brass and other copper alloy manufacturing				-B
Iron and steel manufacturing				-C
Lead manufacturing				-D
Other base metal manufacturing				-E
Food, drink and tobacco manufacturing	MA	02		
Food, drink and tobacco manufacturing	MA	02	A	
Animal and poultry food manufacturing				-A
Bacon curing, meat and fish product manufacturing				-B
Biscuit manufacturing				-C
Bread and flour confectionery manufacturing				-D
Breweries and maltings				-E
Cocoa, chocolate and sugar confectionery manufacturing				-F
Fruit and vegetable product manufacturing				-G
Grain mill				-H
Milk and milk product manufacturing				-I
Soft drinks manufacturing				-J
Sugar refinery				-K
Tobacco manufacturing				-L
Vegetable, animal oil and fat manufacturing				-M
Other drink industry manufacturing				-N
Other food industry manufacturing				-O
Chemical and allied industries manufacturing places	MA	03		
Chemical and allied industries manufacturing places	MA	03	A	
Dyestuffs and pigments manufacturing				-A
Explosives and fireworks manufacturing				-B
Fertilizer manufacturing				-C
General chemical manufacturing				-D
Paint manufacturing				-E
Pharmaceutical chemicals and preparation manufacturing				-F
Soap, detergent and fat splitting and distillation manufacturing				-G
Synthetic resins, plastics and synthetic rubber manufacturing				-H
Toilet preparation manufacturing				-I
Other chemical manufacturing place producing specific functional preparation				-J
Engineering places	MA	04		
Mechanical engineering places	MA	04	A	
Agricultural machinery manufacturing				-A
Construction and earth moving equipment manufacturing				-B
Industrial services equipment manufacturing				-C
Mechanical handling equipment manufacturing				-D
Metal working machine tools manufacturing				-E
Office machinery manufacturing				-F
Ordnance and small arms manufacturing				-G
Prime movers manufacturing				-H
Pumps, valves and compressor manufacturing				-I
Textile machinery and accessories manufacturing				-J
Other mechanical engineering manufacturing				-K

TABLE F.5.2. (Continued)

LAND USE NAME	ORDER	GROUP	SUBGROUP	CLASS
MANUFACTURING (cont'd)	MA			
Instrument enginering places	MA	04		
Instrument engineering places	MA	04	B	
Photographic and document copying equipment manufacturing				-A
Surgical instruments and applicances manufacturing				-B
Scientific and industrial instruments and systems manufacturing				-C
Watches and clocks manufacturing				-D
Other instrument engineering				-E
Electrical engineering places	MA	04	C	
Broadcast receiving and sound reproducing equipment manufacturing				-A
Electric appliances primarily for domestic use manufacturing				-B
Electrical machinery manufacturing				-C
Electronic computers manufacturing				-C
Insulated wires and cables manufacturing				-E
Radio and electronic components manufacturing				-F
Radio, radar and electronic capital goods manufacturing				-G
Telegraph and telephone apparatus and equipment manufacturing				-H
Other electrical goods manufacturing				-I
Shipbuilding and marine engineering places	MA	04	D	
Shipbuilding and marine engineering				-A
Vehicle engineering places	MA	04	E	
Aerospace equipment manufacturing or repairing				-A
Locomotives and railway track equpment manufacturing				-B
Motorcycle, tricycle and pedal cycle manufacturing				-C
Motor vehicle manufacturing				-D
Railway carriages and wagons and trams manufacturing				-E
Wheeled tractor manufacturing				-F
Other metal goods manufacturing places	MA	04	F	
Can and metal box manufacturing				-A
Cutlery and plated tableware manufacturing				-B
Jewellery and precious metal manufacturing				-C
Bolts, nuts, screws, rivets, etc. manufacturing				-D
Small tools, implements and gauges manufacturing				-E
Wire manufacture				-F
Other metal industry manufacturing				-G
Clothing, textiles, leather, footwear and fur goods manufacturing places	MA	05		
Textile manufacturing places	MA	05	A	
Carpet manufacturing				-A
Hosiery and other knitted goods manufacturing				-B
Jute manufacturing				-C
Lace manufacturing				-D
Made-up textile manufacturing				-E
Man-made fibre production manufacturing				-F
Narrow fabric manufacturing				-G
Rope, twine and net manufacturing				-H
Spinning and doubling (cotton and flax systems) manufacturing				-I
Textile finishing				-J

TABLE F.5.2. (Continued)

LAND USE NAME	ORDER	GROUP	SUBGROUP	CLASS
MANUFACTURING (cont'd)	MA			
Textile manufacturing places (Cont'd)	MA	05	A	
Weaving of cotton, linen and man-made fibres manufacturing				-K
Woollen and worsted manufacturing				-L
Other textiles manufacturing				-M
Leather and fur goods manufacturing places	MA	05	B	
Fur goods manufacturing				-A
Leather goods manufacturing				-B
Leather (tanning and dressing) and fellmongery				-C
Clothing and footwear manufacturing places	MA	05	C	
Dresses, lingerie, infants' wear, etc. manufacturing				-A
Footwear manufacturing				-B
Hats, cap and millinery manufacturing				-C
Overalls and men's shirts and underwear manufacturing				-D
Tailored outerwear manufacturing				-E
Weatherproof outerwear manufacturing				-F
Other dress articles manufacturing				-G
Bricks, pottery, glass, cement manufacturing places	MA	06		
Bricks, pottery, glass, cement manufacturing places	MA	06	A	
Abrasives and other building materials manufacturing				-A
Bricks, fireclay and refractory goods manufacturing				-B
Cement manufacturing				-C
Glass manufacturing				-D
Pottery				-E
Timber furniture, paper, printing and publishing works	MA	07		
Timber and furniture works				
Bedding and soft furnishings and manufacturing				-A
Furniture and upholstery manufacturing				-B
Miscellaneous wood and cork manufacturing				-C
Shop and office fittings manufacturing				-D
Timber works				-E
Wooden containers and baskets manufacturing				-F
Paper, printing and publishing works	MA	07	B	
Stationery manufacturing				-A
Packaging products of paper and associated materials manufacturing				-B
Paper and board manufacturing				-C
Periodical and newspaper printing and publishing				-D
Other paper and board manufacturing				-E
Other printing, publishing, bookbinding and engraving manufacture				-F
Other manufacturing places	MA	08		
Other manufacturing places	MA	08	A	
Brushes and brooms manufacturing				-A
Linoleum, plastics floor-covering, leather cloth manufacturing				-B
Miscellaneous goods manufacturing				-C
Miscellaneous stationer's goods manufacturing				-D
Rubber goods manufacturing				-E
Toys, games, children's carriages and sports equipment manufacturing				-F
Other plastics products manufacturing				-G
Construction places	MA	09		
Construction places	MA	09	A	

TABLE F.5.2. (Continued)

LAND USE NAME	ORDER	GROUP	SUBGROUP	CLASS
MANUFACTURING (cont'd)	MA			
Construction places (Cont'd)	MA	09	A	
Construction and demolition site				-A
Manufacturing research	MA	10		
Manufacturing research establishments	MA	10	A	
Industrial research laboratory				-A
Manufacturing waste disposal places	MA	11		
Manufacturing waste disposal places	MA	11	A	
Manufacturing waste tip				-A
Manufacturing storage places	MA	12		
Manufacturing storage places	MA	12	A	
Manufacturing storage place				-A

activities. Thus, BSU's may be whole hereditaments, or they may be subdivisions of hereditaments. In the latter case they must aggregate to whole hereditaments, leaving no voids. For consistency with the recommendations in the GSOP report the term 'BSU' should not be applied to areas larger than hereditaments. Each BSU should be clearly identifiable and self-contained. This implies some kind of natural or man-made observable barrier as the boundary, for example a hedge, an external or internal wall of a building, a fence or ditch and so on. Where such barriers do not exist other well defined features should be used, such as paths, roads, or the edges of paved and other hard surfaced areas. Many physical barriers and features which enclose space are shown on Ordinance Survey 1/1,250 scale maps. These features should be used as far as possible, even though this may entail including within BSU's some land which is not in any use at the time."

2) Hereditaments. The term identifies an area defined for rating valuation purposes. The method of definition is complex and the hereditaments vary widely. The report states:

"it is worth noting that, because occupancy is an important factor, a hereditament will often be of the same extent as a main activity. If, however, it should accommodate two or more activities which are physically separate and it is not to be subdivided into BSU's for the purpose of classification, then classification should relate to whichever main activity is judged to be the most important, and the others disregarded. If the activities overlap and occupy the same area then there will be multiple use and the uses arising from these activities should be recorded and classified separately. The same approach should be adopted for 'dummy' hereditaments, that is parcels of non-rateable land which are treated as hereditaments to prevent voids being left..."

3) Zone. A zone may be of two types: an area entirely in one use; or a generally homogeneous area in which one land use predominates.

"But for the fact that the BISP report reserved the term BSU for hereditaments in a single-use and for subdivisions of hereditaments it could well refer to the single-use zone. The same principle of definition applies to the subdivision and single-use zone, namely that the boundaries are determined by the extent of a main activity. As a result, there will be no loss of accuracy when the single-use zone is employed. Most commonly, it will consist of contiguous hereditaments in residential use."

The classification system may be operated at any of the four levels and in relation to any of the three spatial units.

The coding system is alpha-numeric and consists of six characters (see Table F.5.2). The first two characters are

letters, the next two are numbers, and the last two letters. The first two characters represent the Order, the first four the Group, the first five the Sub-Group, and all six the Class. The code may be used manually or automatically. A column is provided in the hierarchy or classification for SIC code numbers.

Information on the methodology for gathering data is not provided. Considerable ground survey may be necessary.

The classification is to be implemented over a period of time during which it will be modified as necessary. The degree to which it has been adopted by local authorities is not known.

F.6: LAND RELATED INFORMATION SYSTEMS IN ALBERTA

In the 1960's and early 1970's, many provincial and municipal agencies in Alberta required a comprehensive land use classification and coding system. This requirement arose in part because of the need to develop maximum flexibility in the utilization of large volumes of information existing in agency records and available from other sources. The information system capabilities had to be such that they would contribute to:

1. trend analysis over time;

2. analysis of data to assist in determining social or economic aspects of an area or to predict and assess the impact of planning (and similar) decisions over an area;

3. multi-use of coded data;

4. comptability among coding systems;

5. comparability of data with that from other systems; and

6. inter-agency use of data assembled by one agency.

The agencies utilizing land use coding systems included the Provincial Assessor, the major cities, the Provincial Planning Branch of the Department of Municipal Affairs, the Regional Planning Commissions, and other branches of provincial departments with responsibilities for aspects of land use in Alberta. The City of Edmonton adopted a land use classification and coding system in connection with its Population and Land Use System (PLUS). This four-level hierarchical system possessed eight categories at the first, generalized level of classification:

1 Residential
2 Commercial
3 Industrial
4 Institutional
5 Transportation, Communications and Utilities
6 Recreation and Open Space
7 Agriculture
8 Vacant Urban Land

The detailed land use code for the first of these categories, Residential, is shown in Table F.6.1.

Three other agencies, the Provincial Assessor, City of Calgary, and Calgary Regional Planning Commission, sought to create a classification system which would meet the many requirements of each of the organizations. To this end, a two-digit, general land use code was developed with nine categories (Table F.6.2). However, the system as reflected in the Provincial

TABLE F.6.1. CITY OF EDMONTON DETAILED LAND USE CODE FOR RESIDENTIAL CATEGORY ONLY

CODES	LAND USE
1.	RESIDENTIAL
11	Single-family
111	Single-family detached
117	One dwelling unit with other use in structure
119	Accessory buildings (sheds, etc.)
12	Two-family
121	Semi-detached (side by side) - should be identical on each side
122	Duplex (up and down) - should have equivalent number of rooms
123	Conversion - basement suites included
127	Two-family with other use in structure
129	Accessory buildings
13	Three-four family
131	Rowhousing
132	Triplex or fourplex - building assessment between $13,000-$15,000 Assessors code 15
133	Conversion
134	Combined with other use in structure
139	Accessory buildings
14	Multi-family (5 or more units) building assessment above $15,000
141	Rowhousing - assessors code 14
142	Walkup apartment buildings - assessors code 15
143	Apartment building with elevator
144	Conversion
145	Multi-family combined with other uses - where residential is not the predominant use of the parcel, e.g. apartment over store
146	Condominiums
149	Accessory
15	Rooming and boarding houses
151	Boarding house - family combined with roomers
152	Rooming house
1521	Combined with other use in structure
159	Accessory building
16	Permanent mobile home
169	Accessory building
17	Fraternity, sorority and dormitory (group living)
179	Accessory building

TABLE F.6.2. ALBERTA PROVINCIAL ASSESSOR PREDOMINANT LAND USE CODES

CODES	LAND USE
00 - 09 =	UNUSED
01 =	Land
02 =	Derelict
03 =	Water-permanent
04 =	Water-impermanent
05 =	Improvement
10 - 19 =	RESIDENTIAL
10 =	Detached house
11 =	Semi-detached and duplex
12 =	Apartment
13 =	Row housing
14 =	Collective residential
15 =	Mixed residential
19 =	Ancillary building
20 - 29 =	COMMERCIAL
20 =	Retail establishments
21 =	Eating and drinking establishments
22 =	Business and personal service establishments
23 =	Transportable home park
24 =	Transient accommodation
25 =	Shopping centre
26 =	Wholesaling
27 =	Warehousing and storage
29 =	Ancillary
30 - 39 =	INDUSTRIAL
30 =	Food processing
31 =	Manufacturing
32 =	Extractive Industries
33 =	Construction Trades and Contractors
39 =	Ancillary
40 - 49 =	AGRICULTURAL
40 =	Mixed farm
41 =	Field crops
42 =	Unimproved livestock pasture and forage
43 =	Unimproved livestock pasture
44 =	Commercial horticulture
45 =	Intensive commercial livestock uses
46 =	Agriculture
50 - 59 =	TRANSPORTATION
50 =	Air

CODES	LAND USE
50 - 59 =	TRANSPORTATION (Cont'd)
51 =	Rail
52 =	Automotive
53 =	Parking facilities
54 =	Road and pedestrian right-of-way.
55 =	Commercial pipelines
56 =	Other
60 - 69 =	UTILITIES AND COMMUNICATION
60 =	Telephone and telegraph
61 =	Radio and television
62 =	Gas
63 =	Electricity
64 =	Domestic water
65 =	Irrigation
66 =	Sewerage
67 =	Garbage
68 =	Post office
70 - 79 =	INSTITUTIONAL
70 =	Education services
71 =	Social welfare institutes
72 =	Cultural facilities
73 =	Medical and health services
74 =	Protective and correctional facilities
75 =	Armed forces
76 =	Religious facilities
77 =	Public and private non-profit offices
80 - 89 =	RECREATIONAL
80 =	Indoor activities
81 =	Outdoor activities
82 =	Social clubs and community facilities
83 =	Parks and campgrounds
90 - 99 =	FORESTRY
90 =	Timber processing
91 =	Productive woodland
92 =	Non-productive woodland

Assessor's detailed land use code (Tessari, 1974, Appendix 2), was found not to be compatible at the third and fourth levels with the existing conditions, procedures, and modes of utilization extant in the other agencies.

These existing land use classifications were considered by the Task Force on Urbanization and the Future. In 1974, the Task Force completed a three-part report on Land-Related Information Systems which attempted to:

> "incorporate the best features of the codes published in the Standard Land Use Coding Manual and coding systems developed by several agencies in Alberta, in a logical approach to the development of a coding structure suitable for adoption as a standard provincially...
>
> "While no classification system is suggested for tax and assessment considerations, it is recognized that such need exists among several agencies in the province and this report recommends that development of a standardized system in this field should be pursued." (Tessari, 1974).

The Task Force proposal for classification distinguishes between the several characteristics or dimensions which together reflect the outward manifestations or observable elements of land and suggests a separate classification system for each such characteristic, including:

1) land use,
2) ownership,
3) occupancy, and
4) economic activity.

General land use, under a single-digit code structure, contains ten main categories which are compatible with Table F.6.2 (Table F.6.3). Two additional breakdowns provide greater detail through the introduction of both two- and three-digit codes in hierarchical order. (Only the first and second levels are shown in Table F.6.3). The two-digit code may be viewed as a facility or resource code; and the third-level information describes physical activity. Tessari (1974) stated that "standardization at the three-digit level should be adequate for most applications and the scope of this report is limited accordingly". Where the demand seems to exist, however, as in the Commercial and Industrial categories, four-digit codes may be employed.

With respect to ownership single-digit coding is proposed for the purpose of separating Public from Private ownership, as well as several types of foreign ownership. Corresponding two-digit codes reflect detail of ownership under these two main categories.

As to occupancy this classification applies to a facility rather than to the land on which it is located. Thus, for example, an apartment situated on a property is a form of "land use" rather than "occupancy". The land use accordingly is Residential. The principal intent of the occupancy code is to specify the manner of occupancy of the apartment and includes codes for: owner occupied; renter occupied; owner and renter occupied; and vacant (and partially vacant).

Land which is bereft of use and any facility or recognized resource, is classified under the major category Unused.

TABLE F.6.3. TASK FORCE ON URBANIZATION, ALBERTA LAND USE CLASSIFICATION (LEVELS ONE AND TWO ONLY)

LEVEL I	LEVEL II	LAND USE
0		UNUSED
	01	Dry land
	02	Reservoir
	03	Dugout
	04	Lake
	05	Water course
	06	Slough
	07	Muskeg
	08	Improvement
1		RESIDENTIAL
	10	Single family residence
	11	Two family residence
	12	Three-four family residence
	13	Multi-family residence
	14	Collective residence
	15	Rooming and boarding house
	16	Residential accessory
	17	Subapartment
2		COMMERCIAL
	20	Retail establishment
	21	Eating and drinking establishment
	22	Business and personal service establishment
	23	Auction service
	24	Transient accommodation
	25	Shopping centre
	26	Wholesale establishment
	27	Warehouse and storage facility
3		INDUSTRIAL
	30	Food processing
	31	Manufacturing
	32	Extractive industries
	33	Construction trades and contractors
	34	Printing, publishing and allied
4		AGRICULTURAL
	40	Dryland farm
	41	Irrigated farm
	42	Intensive livestock
	43	Animal specialty
	44	Horticulture
	45	Apiculture
	46	Experimental and institutional farms
5		TRANSPORTATION
	50	Air
	51	Railroad
	52	Rapid rail
	53	Motor vehicle - freight
	54	Motor vehicle - bus
	55	Motor vehicle - other
	56	Parking facility
	57	Road, street and pedestrian right-of-way
	58	Commercial pipeline
	59	Marine
6		UTILITIES AND COMMUNICATIONS
	60	Telephone and telegraph
	61	Radio and television
	62	Gas
	63	Electricity
	64	Domestic water
	65	Irrigation
	66	Sewerage
	67	Garbage
	68	Post office
7		INSTITUTIONAL
	70	Education
	71	Social welfare
	72	Cultural and community
	73	Medical and health services
	74	Protective and correctional
	75	Military
	76	Religious
	77	Non-profit offices
	78	Mortuaria
8		RECREATIONAL AND ENTERTAINMENT
	80	Indoor entertainment
	81	Outdoor entertainment
	82	Indoor athletics
	83	Outdoor athletics
	84	Parks and campgrounds
9		NATURAL RESOURCE
	90	Forestry - productive
	91	Forestry - nonproductive
	92	Forest protection
	93	Commercial deposits
	94	Fish and game animals
	95	Fur animals

The report recommends that in respect of economic activity the Standard Industrial Classification* be adopted as the standard coding system whereby economic activity is recorded. Wherever possible at level three of the land use codes the appropriate SIC number or numbers are introduced in a separate column.

Tessari observed that these four areas represent but a portion of the total land record required to serve the broad spectrum of users. He cited other possible attributes of a parcel of land which may be recorded, including: street and avenue address; legal description; building type or improvement code; segment of single-storey buildings and floor of multi-storey structures on which a particular land use occurs; square footage of buildings; tax status code; and assessment role number and code.

*Statistics Canada, 1970. Standard Industrial Classification. Canada, Department of Industry, Trade and Commerce.

F.7: QUEBEC URBAN AGGLOMERATION LAND USE CLASSIFICATION

In recent decades, the Province of Québec has experienced rapid urbanization, largely in the immediate area around Montréal, but also to a significant degree in metropolitan Québec City. In 1971, under the authority of the Office de planification et développement du Québec (1975), staff from Laval University and the University of Montréal surveyed urban land use in 62 agglomerations in the province (Raveneau et al., 1973; Villeneuve and Gagnon, 1975). The land use classification employed in the survey is shown on Table F.7.1.

The survey was made largely in the field and the field data transferred to large-scale maps ranging in scale from 1:5,000 to 1:25,000. The urban agglomerations were delimited according to the distribution of the built-up areas rather than their administrative boundaries.

The analysis of the data showed that the area of agglomeration in the province varied from 133,000 acres (Montréal) to 400 acres for the smallest towns. The consumption of urban space fluctuated from 0.04 acres per inhabitant to 0.20. The mean percentage occupied by the major classes of land use for all agglomerations was: residential - 47.3%; commercial - 6.8%; institutional - 8.4%; green space - 8.5%; industrial - 12.3%; and para-urban - 16.7%. Vacant lots (urban unimproved land) were not included in the total of the agglomerations urbanized areas; they possessed a mean area equal to 74% of the area covered by the other classes of urban land use.

TABLE F.7.1. LAND USE CLASSIFICATION, URBAN AGGLOMERATIONS, QUEBEC, 1971

CLASSES AND CODES	LAND USE
R: RESIDENTIAL ZONES	
R_a:	Areas of new bungalows. These are detached, single-family houses built after 1945-50, the style of which contrasts clearly with that of houses built during the first half of the century or earlier. The density is low, each house normally containing only one dwelling unit. These houses range in value from $10,000 to $30,000 (1971).
R_b:	Areas of luxury dwellings. Single-family dwellings valued at more than $30,000 - $35,000 (1971).
R_c:	Areas of older detached dwellings with one or two storeys and containing one, two or more dwelling units. Medium density. These dwellings were built before 1945 and are often found at the centres of small towns. As these houses are generally more spacious than modern bungalows, they are often divided into two or more dwelling units.
R_d:	Duplexes, triplexes, semi-detached and row houses. Medium to high density.
R_e:	Apartment buildings of 3 to 6 storeys. High density.
R_f:	High-rise apartment buildings, more than 6 storeys. Very high density. Found mostly in Montréal and Québec City.
R_g:	Trailer parks and cottage areas.
C: COMMERCIAL AND BUSINESS ZONES:	Areas used for businesses, services, offices, garages, motels and in general anything relating to the tertiary sector.
C_a:	The central business district. The downtown area of smaller centres. Some cities may have more than one central area.
C_b:	Shopping districts.
C_c:	Secondary commercial zones.
U: INDUSTRIAL ZONES	In addition to industrial sites as such, this category includes storage yards, truck yards, lumberyards, and the like, as well as such large areas as mine pits, spoil heaps and landfill sites.
E_a:	OPEN SPACES Parks, golf courses, campgrounds, beaches, and the like.
E_b:	INSTITUTIONS Institutional buildings and the spaces functionally associated with them: churches, schools, hospitals, convents, arenas and stadiums, community centres.
P:	SEMI-URBAN Cemeteries, interchanges, highways, dumps, automobile graveyards, railway yards, hydro rights-of-way, quarries, radio and television towers, and so on.
S:	VACANT OR SPECULATIVE LAND Undeveloped areas contained within the city limits or located at the fringes between the urbanized area and the major transportation routes. S is relatively easily identified for land bounded on three or four sides by urbanized land. At urban fringes, the extension of S depends on the boundaries of the agglomeration.

F.8: NOVA SCOTIA DEPARTMENT OF MUNICIPAL AFFAIRS SETTLEMENT ORIENTED LAND USE CLASSIFICATION

In June, 1978 the Community Planning Division of the Province of Nova Scotia's Department of Municipal Affairs (1968) reported on its settlement-oriented land use classification which had been developed during the previous few years. The classification has been used in a land use survey of parts of Nova Scotia. The land use survey has five principal aims:

1. To provide a detailed and accurate information base relating to land use to meet departmental information requirements, and similarly to assist other government departments and municipalities;

2. To provide land use information for the preparation of regional and municipal development plans;

3. To provide information basic to achieving objectives identified by the Joint Union of Nova Scotia Municipalities and the Department of Municipal Affairs Task Force;

4. To provide information required for residential development analysis; and

5. To develop methodology for the compilation, presentation, reproduction and dissemination of land use information compatible with the Land Registration and Information System of resource and property mapping out 1:10,000 and digitizing of data.

The land use survey will be conducted in seven regions into which the province has been split. In each region, the land use survey will begin with priority areas.

Land use is to be classified according to the categories shown in Table F.8.1. The sources of information will be air photos or orthophotos, field survey, and other, previously gathered collections of information. Contact with an area's residents will be minimal. Aerial photography for most of the province is available in colour at a scale of 1:10,000 (1973-1977).

TABLE F.8.1. NOVA SCOTIA SETTLEMENT LAND USE CLASSIFICATION

FIELD CODE	LAND USE
	RESIDENTIAL
F	Farm dwelling
S	Other single family dwelling
E	Residence and non-residential unit combined
T	Two family dwelling*
Y + no.	Multiple family dwelling*
Z + no.	Senior citizen row housing and apartments
M	Mobile home
P + no.	Trailer park
L	Lodging and rooming houses, homes
V	Vacant, deteriorating, abandoned
U	Under construction
R	Recent dwelling (FR, SR, ER, TR, YR) (approximately last 10 years)
D	Subidivision*
	COMMERCIAL AND BUSINESS (C)
CR	Retail and wholesale trade establishments, business, sales and service
CE	Indoor recreation, entertainment
CD	Dining and drinking establishments
CH	Hotel
CM	Motel
CB	Bank
CA	Automotive sales, service, service station
CF	Farm machinery sales, service
CG	Grain, feed, seed
CS	Shopping centre
	INDUSTRIAL (I)
IE	Mines, quarries, pits* (extraction)
IH	Petrochemicals
II	Metal manufacturing
IT	Transportation equipment
IB	Ship/boat building
IR	Engineering/machinery/electrical
IM	Other metal goods
IC	Cement, concrete
IS	Saw mill*
IU	Pulp and paper mill*
IO	Pulp storage yard
IN	Furniture
IA	Cartons, containers
IZ	Other wood or paper products
IF	Food processing (exclusive of dairy and fish products)
ID	Dairy, creamery
IG	Fish processing*
IV	Beverages
IQ	Feed mill
IX	Textiles
IL	Leather, footware
IW	Clothing
IY	Pottery, glass
IJ	Stone, brick
IK	Large warehouses, extensive storage yards
Ig	Gas and oil storage tanks

*Denotes another or additional source of information other than field survey.

TABLE F.8.1 (Continued)

FIELD CODE	LAND USE
	INDUSTRIAL (I) (cont'd)
Ij	Salvage yards, automobile junkyards
IP	Industrial park
Il	Other (miscellaneous small industries)
	GOVERNMENT AND INSTITUTIONAL (G)
GO	Government office (exclusive of the following)
GH	Department of Highways*
GL	Department of Lands and Forests*
P.O.	Post Office
GP	Police
GX	R.C.M.P.
GF	Fire station
GS	Educational (school, vocational, college, university, etc.)
GB	Library
GE	Medical (hospital, clinic, psychiatric)
GZ	Senior citizen home, nursing home
GT	Correctional (prison, correctional farm)
GR	Religious (church, seminary, religious order, etc.)
GC	Cemetery
GN	Community hall
GY	Youth associations
GU	Museum
GM	Military (establishment, reserve, base)
	UTILITIES (U)
US	Sewage treatment facilities*
UI	Incinerator
UD	Public dump*
UX	Unofficial garbage dump
UA	Auto dump (10 or more cars)
UZ	Power transmission line*
UE	Electricity generating station*
UB	Electricity substation*
UN	N.S. Power Corporation storage areas*
UW	Water tower*
UR	Reservoir*
UK	Prescribed water supply areas*
UT	Water treatment plant*
UC	Communication facilities (telephone, radio, T.V., microwave)
	TRANSPORTATION (T)
TR	Railroad station*
TY	Railroad yard
TB	Bus terminal
TT	Truck terminal
TM	Marine facilities* (wharf, dock, etc.)
TH	Lighthouse*
TA	International airport*
TN	National airport*
TL	Local (flying club)
TX	Military airfield
TB	Abandoned airfield

*Denotes another or additional source of information other than field survey.

TABLE F.8.1 (Continued)

FIELD CODE	LAND USE
	RECREATION (R)
C	Cottage
RB	Tourist bureau*
RP	Provincial park*
RF	Federal park*
RV	Private campground (tents, trailers, structures)
RU	Public campground
RT	Picnic tables, areas
RS	Sports field
RA	Play area
RG	Golf course
RD	Driving range
Rg	Mini-golf
RE	Drive-in theatre
RK	Ski slopes
RX	Riding
RL	Harness race track
RZ	Auto race track
RY	Yacht club
RM	Marina, boat centre
RN	Tennis
RW	Amusement park, fairground, exhibition grounds
RJ	Zoo
RH	Historic site*
RI	Other outdoor recreation
RR	Indoor recreation (non-commercial)
NOTE: Recreational facilities associated with schools are included as mapped with school symbol.	
	AGRICULTURAL
O	Orchards
N	Nurseries, greenhouses
B	Barn and related buildings
Ch	Poultry building*
H	Hog barn*
K	Mink farm*
A	Cleared area* Predominantly agricultural land. Includes: horticulture; field crops (corn, grain); small gardens, hay; other crops; improved pasture; rough unimproved pasture; abandoned land; idle grassland
	FISH AND WILDLIFE (W)
WG	Fish processing plant*
WH	Fish hatchery*
WP	Wildlife preserve*
WS	Game sanctuary*
	OTHER
	Approximate limit, city, town, village* Note signs.
BUA	Built-up area
RES	Indian reserve*
BOG	Marsh, swamp, bog*

*Denotes another or additional source of information other than field survey.

F.9: MONROE COUNTY, NEW YORK LAND USE CLASSIFICATION

Monroe County Department of Planning in 1973 published the Land Use Classification System. The purpose of the volume is "to develop a system to collect, classify and maintain computerized land use data". The report also contains a land use coding system and the system as a whole has been designed to be compatible with the data systems of other agencies working in planning and data collection within New York State and, more specifically, Monroe County. The County's Department of Planning has utilized work by the New York State Board of Equalization and Assessment. The New York system was selected over the United States Standard Land Use Code (SLUC), the State of Oregon SLUC and other systems largely because it was already being implemented in the county for use by assessors and for inclusion in existing tax role computer files.

The key to the success of the system is said to be the abandonment of a complex four-digit land use code in favour of a three-digit code. For each parcel of land up to 19 data items were to be maintained on a planning file:

1. Owner's name
2. Property address
3. Lot number, twp., block, range, section
4. Property character
5. School district
6. Total acres
7. Full value of land only
8. Full value of land and improvements
9. Valuation exemptions
10. Aged exemption
11. Parcel account number
12. Special districts
13. Legislative district
14. Land use
15. Number of dwelling units
16. Zoning code
17. Comprehensive plan code
18. Split parcel acres
19. Census tract

The land use classification is of a model property type and contains nine categories at the first, generalized level; 60 subcategories at the second level, and 141 third level subcategories. The first level categories are shown in Table F.9.1

F.10: METROPOLITAN TORONTO PLANNING BOARD LAND USE CLASSIFICATION

In its 1973 volume, Metropolitan Toronto Land Use Surveys, 1958-1971 the Research Division of the Metropolitan Toronto Planning Board reported that land use data for the Board's area of responsibility were first compiled in 1958. There were further surveys between 1958 and 1971, and, in 1963, land use maps were prepared at a scale of 1 inch to 1,000 feet. A land use manual was prepared in 1958 for land use classification purposes, but because of ad hoc changes in survey methods, the data series for the 1,000-foot surveys contained both inconsistencies and biases in the interpreation of land use assignments. A number of examples are provided.

1. "There is a lack of refinement in sub-classification, e.g., single categories of "retail" and "industrial". The Industrial group contains a category of "warehousing" but this distinction has not been consistently maintained.

TABLE F.9.1. MONROE COUNTY, NEW YORK LAND USE CLASSIFICATION (LEVEL ONE ONLY)

LEVEL I CATEGORIES		LAND USE
100	Agriculture	Property used for the production of crops or livestock (e.g. livestock and products; field, truck and orchard crops; fruits, nursery and greenhouse stock; fur products; and fish and wildlife preserves).
200	Residential	Property used for human habitation (e.g. year-round residences, rural residences, with acreage, estates, seasonal residences and individual mobile homes).*
300	Vacant Land	Property that is not in use, in temporary use, or without permanent improvement (i.e. residential, rural commercial, industrial, and urban development or slum clearance).
400	Commercial	Property used for the sale of goods and/or services (e.g. non-residential living accommodations, dining establishments, motor vehicle services, storage warehouse and distribution facilities, retail services, bank and office buildings, and multi-purpose buildings).**
500	Recreation and Entertainment	Property for the congregation or gathering of groups for recreation, amusement, or entertainment (e.g. entertainment or sports assemblies, amusement facilities, indoor and outdoor sports facilities, improved beaches, marinas, camps, resorts, and parks).
600	Community Services	Property used for the well-being of the community (e.g. health facilities, education, cultural centres, correction facilities, welfare, and government facilities).
700	Industrial	Property used for the production and fabrication of durable and non-durable man-made goods (e.g. manufacturing, mining and quarrying, and wells).
800	Public Services	Property used to provide services to the general public (e.g. gas and electric, water, communication, transportation and waste disposal).
900	Wild and Forested Lands	Forested lands, preserves, and private hunting and fishing clubs.

* Other living accommodations such as hotels, motels, and apartment are in the major division - Commercial.

**Multi-purpose building is one which could be used by more than one occupation without serious alteration to the structure (e.g. the small retail store could very easily be converted into a barbershop).

2. "There is inconsistency in sub-classification in terms of the criteria used. For example, in the commercial group "retail" expresses an economic function; "gas station" on the other hand, although performing a retail function is more readily identified as a building or facility type.

3. "Within major use groups, sub-classification does not deal consistently with the assignment of uses which do not belong to the specific categories named. In the Commercial group "other" uses are assigned to "retail" and in Residential, to "family residential". (Metropolitan Toronto Planning Board, 1973).

In 1971, new land use mapping for Metropolitan Toronto was performed at a scale of 1 inch to 400 feet. Land uses were entered on the map in letter code form. The classification system consisted of a two-letter code of which an upper-case letter denoted a main-use class and a lower-case letter, the subcategories within each (Table F.10.1). A two-digit numerical code was added for data-processing purposes.

"The main classes are termed Activity Classes based on the approach that use of land is an expression of human activity involving varying degrees of interactions between persons, goods or services and modes of transportation. By relying on one set of identifying criteria for each activity class, it is hoped to achieve mutual exclusiveness of definition of specific uses named in the sub-classification as well as the group ing of 'other' uses not specifically named. "(Metropolitain Toronto Planning Board, 1973).

The report also observes that the criterion which will be present most often in the classification process is the Building or Facility Type which constitutes the basis of sub-classification. This situation arises because, during site identification, the thought process "this building was designed for use as..." usually is applied by the technician.

In 1971, the field survey work included the assignment of Standard Industrial Classification (SIC) codes to all enterprises on sites within areas designated industrial in the Metropolitan Plan. (See also Bourne and Griffith, 1975).

TABLE F.10.1. METROPOLITAN TORONTO PLANNING BOARD LAND USE SURVEY 1971 PHYSICAL LAND USE CLASSIFICATION

CODE	ACTIVITY CLASS and FACILITY TYPE	DESCRIPTION
(R)	RESIDENTIAL	ACTIVITIES ASSOCIATED WITH HOUSEHOLD ORGANIZATION AT PLACE OF PERMANENT SHELTER AND HOME-BASE FOR OTHER ACTIVITY TRIPS
	(Individual Dwellings)	(each building or recognized unit of a structure associated with exclusive use of site area, street frontage and access; that is)
Rd (11)	Detached Dwelling	building assoc. with use as one dwelling unit
Rs (12)	Semi-detached Dwelling	building with 2 dwellings attached side-by-side
Rt (13)	Attached Dwelling	building with (or formed by) 3 or more dwellings attached side-by-side but each comprising a separate property unit
Re (14)	Estate Dwelling	detached dwelling with extensive grounds (i.e. not regular subdivision lots)
	(Multiple Dwellings)	(Buildings with 2 or more dwellings which share areas of use, street frontage and access; that is)
Rh (15)	Horizontal Multiple	a building containing three or more dwellings arranged (primarily) side-by-side, allowing some areas of individual use or separate means of entrance within the site
Ra (16)	Apartment Building	a building containing six or more (or groups of six or more) dwellings arranged both horiz. and vertically sharing common entrance at street level and sharing use of site open space, etc.
Rm (17)	Other Multiples	including dwellings arranged 2 or 3 units high (plexes); and other buildings containing several units or other multiple or collective occupancies
	(Other Residence)	(as noted)
Rx (18)	Other Dwellings	miscellaneous structures used (trailers) or converted to use as dwellings
Ry (19)	Other Residential Land	Parts of residential lots not obviously developed or maintained as part of the dwelling curtilage (i.e. potential for re-subdivision)
(C)	SHOPPING	ACTIVITIES INVOLVING ATTRACTION OF THE GENERAL PUBLIC FOR ONSITE PURCHASE OR CONSUMPTION OF GOODS, AND SERVICES TO PERSON OR PERSONAL EFFECTS
Cc (21)	Shopping Centre	several stores designed as a unit with integrated parking and access facilities

TABLE F.10.1. (Continued)

CODE	ACTIVITY CLASS and FACILITY TYPE	DESCRIPTION
(C)	SHOPPING (cont'd)	
Cs (22)	Shopping Strip	several buildings or shopping units attached to form continuous frontage along a street
Ci (23)	Individual "Stores"	store and service buildings on separate sites
Cx (24)	Other Shopping Premises	other display, sales and service buildings, structures, lots
Cg (25)	Automotive Premises	buildings and other premises used for sale and (routine) servicing of cars, similar private vehicles, parts and supplies
Ca (26)	Accommodations	hotels, etc., associated primarily with accommodations for travelling public
(O)	OFFICE	ACTIVITIES INVOLVING PERSONS ENGAGED PRIMARILY IN ADMINISTRATIVE, MANAGEMENT AND CONSULTATIVE WORK AND SERVICES
Ot (31)	Office Tower	building vertically dominant (and generally more than 6 floors)
Ob (32)	Office Block	building horizontally dominant (or generally less than 7 floors)
Ox (33)	Other Office Building	small building (not generally more than 3 floors), often mixed use and/or converted dwelling, stores, etc.
(A)	INDOOR RECREATION AND ASSEMBLY	ACTIVITIES INVOLVING INDOOR ASSEMBLY OF GENERAL PUBLIC FOR ENTERTAINMENT, RECREATIONAL, CULTURAL PURSUITS OR EVENTS
Aa (41)	Auditoria	buildings for large-scale assembly of spectators
Af (42)	Facilities	premises associated with consumer participation in activities
Aw (43)	Place of Worship	buildings for religious assembly
Ae (44)	Exhibits	buildings associated with cultural, educational, etc., collections and displays
Ax (45)	Other Assembly	other meeting places
(P)	OUTDOOR RECREATION AND ASSEMBLY	ACTIVITIES INVOLVING ENTERTAINMENT, RECREATIONAL AND LEISURE USE OF OPEN SPACE (INCLUDING BUILDINGS IN OPEN SPACE SETTING)
Pp (51)	Parks and Playgrounds	areas for general or mixed recreation -- leisure activities

TABLE F.10.1. (Continued)

CODE	ACTIVITY CLASS and FACILITY TYPE	DESCRIPTION
Pf (52)	Facilities	areas associated with specialized facilities for participant sports or recreational activities
Ps (53)	Stadia	enclosed areas for spectator oriented activities
Pg (54)	Golf Courses	areas and related facilities for playing golf
Pc (55)	Cemeteries	burial grounds
Pr (56)	Park Reserves	areas of natural landscape, conservation or unimproved parkland
Px (57)	Other Open Space	other amenity or incidential open space (possibly to other uses by ownership)
(I)	INSTITUTIONAL	ACTIVITIES ASSOCIATED PRIMARILY WITH COMMUNITY ORGANIZATION PROTECTION AND GENERAL WELFARE (NOT ELSEWHERE CLASSIFIED)
Is (61)	Schools	places of child and juvenile education
Iu (62)	Universities and Colleges	places of 'higher' and adult education
Ih (63)	Hospitals	places associated with active medical treatment
Ic (64)	Care and Custodial	accommodations associated with institutionalized care and custodial supervision.
Ig (65)	Law Enforcement Protection and Defence Establishments	community service and protection establishments, e.g. fire, police, armories, national and civil defence
Ix (66)	Other Institutional Premises	miscellaneous premises of institutional type organizations not classified elsewhere
(M)	INDUSTRIAL	ACTIVITIES INVOLVING MANUAL, MECHANICAL OR CHEMICAL PROCESSES IN THE PRODUCTION OF MINERALS, GOODS AND EQUIPMENT (EXCLUDING AGRICULTURE)
Me (71)	Mines	sites and equipment associated with mineral extraction, on-site processing, etc.
Mh (72)	Heavy Plant	large factories and processing plants of bulky and/or unsightly nature and/or associated with emissions of dirt, smoke, noise, odours beyond the site
Mg (73)	Other Factories	buildings enclosing industrial operations on a moderate scale

TABLE 5.10.1 (Continued)

CODE	ACTIVITY CLASS and FACILITY TYPE	DESCRIPTION
Mw (74)	Workshops	buildings enclosing small scale industrial operations and related services
Mx (75)	Other Premises	mixed and miscellaneous premises associated with industrial operations and related services
(T)	TRANSPORTATION	ACTIVITIES INVOLVING VEHICLES IN THE CONVEYANCE OF PASSENGERS AND FREIGHT
Te (81)	Expressway Right-of-Way	limited access highway and interchanges
Tr (82)	Other Transportation Right-of-Way	land corridors for (exclusive) use of transportation vehicles, e.g. rail, transit, canal
Ta (83)	Airport	buildings and all property reserved to air transportation
Ts (84)	Other Passenger Stations	stations, etc., for transfer of passengers
Td (85)	Vehicle-Freight Depot	Depots for transfer of freight, storage and maintenance of vehicles
Tp (86)	Parking - Auto	(separate) structures and lots for parking (pte.) automobiles
Tx (87)	Other Transportation Facility	e.g. towers, beacons, turning loops
(U)	UTILITIES AND COMMUNICATIONS	ACTIVITIES INVOLVING PRODUCTION-DISTRIBUTION OF UTILITY AND COMMUNICATION SERVICES
Uh (91)	Hydro Right-of-Way	land corridors for (exclusive) use of overhead electricity power lines
Ur (92)	Other Utility Right-of-Way	e.g. surface pipeline
Ub (93)	Main Building	buildings enclosing production and other equipment
Up (94)	Open Plan	open or extensive sites and facilities
Ux (95)	Other Utility Facilities	e.g. substations, transmitters, water towers, etc.
(W)	STORAGE	ACTIVITIES INVOLVING PERSONS HANDLING GOODS FOR BULK STORAGE AND/OR INTRANSIT FOR USE OR SALE ELSEWHERE
Wb (101)	Storage Building	building for indoor storage
Wy (102)	Storage Yards, Open Areas	open areas for storage
Ws (103)	Other Storage Structures	e.g. tanks, silos, elevators
(V)	VACANT OR AGRICULTURAL LAND AND MISCELLANEOUS OPEN SPACE	

TABLE F.10.1 (Continued)

CODE	ACTIVITY CLASS and FACILITY TYPE	DESCRIPTION
Va (111)	Areas	extensive areas of farmland or other undeveloped lands...
Vp (112)	Parcels	(smaller) areas and parcels of undeveloped land among or adjacent to sites developed for urban uses
Vp (113)	Part Sites	unimproved portions of developed properties considered unlikely to become separate sites by virtue of size, lack of access or special ownership characteristics
Vs (114)	Unused Sites	sites with buildings or other facilities not currently in use, or subject to demolition
Supplementary Notations		(as defined in attached notes)
Secondary Use		the letter notation for primary use placed in parentheses, e.g., (Rd), (Rs), etc.
Double Use		two notations for primary and secondary uses, and the symbol (2), e.g., Tp, (Uh) (2)
Public Use		normal letter notation with an asterisk, e.g., Is*

F.11: NORTHEASTERN ILLINOIS METROPOLITAN AREA PLANNING COMMISSION LAND USE CLASSIFICATION

The Northeastern Illinois Metropolitan Area Planning Commission published its Land Use Handbook, A Guide to Undertaking Land Use Surveys in 1961. The Handbook was prepared for two reasons. First, it was intended to provide municipalities, planning commissions, and other agencies in the Metropolitan Area with a practical, standardized system for classifying land according to its uses. Secondly, it served as an introduction to the methods and purposes of land use mapping for citizens who might be interested in community planning, but who were not active participants.

A nine-category hierarchical land use classification system is presented in the Handbook with an accompanying index. The degree of detail in each category depends on the scale of the map which is to be prepared. Table F.11.1 shows that the nine categories are presented at "community", "county", and "metropolitan" scales in columns A, B, and C respectively. Each aspect of activity or cover is accompanied by a suggested category and sub-class each of which have available matching Prisma Colour and Zip-A-Tone numbers for land use maps which are to be prepared in colour or in patterns.

When a lot, block, or other defined area is occupied by more than one land use, the multiple uses are recorded in field maps (field survey being the principle method whereby land use information is gathered). Smaller-scale maps (1 inch to 300 ft. or more) will show only the predominant use (usually ground-floor use) of land. Maps prepared at the "community" scale (see column A in Table F.11.1) display all of the multiple uses through divisions of the lot into uses according to a prescribed reporting procedure.

TABLE F.11.1. NORTHEASTERN ILLINOIS METROPOLITAN AREA PLANNING COMMISSION LAND USE CLASSIFICATION

COLUMN A (COMMUNITY SCALE)	COLUMN B (COUNTY SCALE)	COLUMN C (METROPOLITAN SCALE)
Detail Surveys of Buildings and/or Land Use: 1" = 200' & Larger Scales	Predominant Land Use Surveys and Analyses Scale: 1" = 200' - 1" = 900'	Scale: 1" = 1000' & Smaller Scales
1. RESIDENTIAL DWELLINGS		1.0 Residential of all types
11.1 Single Family Dwellings For large estates, indicate grounds separate from buildings with	11 DWELLINGS, 1 or 2 Family and Row Housing For large estates, indicate grounds separate from buildings with	
11.2 Two Family Dwellings		
11.3 Row Housing		
RESIDENTIAL BUILDINGS		
15.1 Multi-family dwellings & apartments	15 RESIDENTIAL BLDGS., including multi-family dwellings, apartments, lodging & rooming houses, apartment hotels, resident clubs	
15.2 Apartment hotels, residential clubs		
18.0 Trailers and other semi-permanent housing	18 TRAILERS & other semi-permanent housing	
2. BUSINESS & COMMERCIAL		2.0 Business & Commercial of all types
21.1 Retail Business - sales and services	21 Retail Business, including commercial indoor rec. & entertainment, hotels, motels	
21.2 Commercial indoor recreation and entertainment		
21.3 Hotels, Motels		
22.0 Offices, Banks, etc.	22 Offices, Wholesales	
22.1 Wholesale merchants, sales-rooms, (excluding warehouses)		
24.1 Automotive - service stations, garages, car & trailer sales, etc.	24 Automotive, including parkings areas	
24.2 Parking Areas - parking lots and garages, public and private		

TABLE F.11.1. (Continued)

COLUMN A (COMMUNITY SCALE)	COLUMN B (COUNTY SCALE)	COLUMN C (METROPOLITAN SCALE)
Detail Surveys of Buildings and/or Land Use: 1" = 200' & Larger Scales	Predominant Land Use Surveys and Analyses Scale: 1" = 200' - 1" = 900'	Scale: 1" = 1000' & Smaller Scales
3. INDUSTRIAL		
31.0 Manufacturing	31 Manufacturing	3.1 Industrial, Manufacturing & Non-Manufacturing
32.0 Industrial Non-Manufacturing - warehouses, storage yards, contractors, yards, oil storage, etc. NOTE: Where necessary for clarity on manufacturing and non-manufacturing sites, show major buildings separate from open areas	32 Industrial Non-Manufacturing	
33.0 Mines, Mineral Workings, Earth Products Removal NOTE: If desired, add "N" for industries which are considered to be noxious in the community because of sight, odour or noise or as specified in the Zoning Ordinance.	33 Mines, Minerals, Earth Products Removal - Add "N" for noxious industries	3.3 Mines, Minerals, Earth Products Products Removal
4. TRANSPORTATION SERVICES		
40.0 Roadways	41 Principal Roads - tollways, expressways	4.1 Principal roads
	42 Other Roads	4.2 Other roads
43.0 Railroads and Rail Mass Transit	43 Railroads & Rail Mass Transit	4.3 Railroads and Rail Transit
44.0 Air Transportation	44 Air Transportation	4.4 Air Transportation
45.0 Road Transportation - bus garage, truck terminals, etc.	45 Road Transportation	
46.0 Other Transportation - marine facilities, pipeline stations, etc. NOTE: Where necessary for clarity, show terminal buildings for passengers & freight separately enclosed in black outline.	46 Other Transportation	4.6 Other Transportation - road, marine, etc.

TABLE F.11.1. (Continued)

COLUMN A (COMMUNITY SCALE)	COLUMN B (COUNTY SCALE)	COLUMN C (METROPOLITAN SCALE)
Detail Surveys of Buildings and/or Land Use: 1" = 200' & Larger Scales	Predominant Land Use Surveys and Analyses Scale: 1" = 200' - 1" = 900'	Scale: 1" = 1000' & Smaller Scales
5. PUBLIC, CULTURAL, EDUCATIONAL & RELATED		
NOTE: For particular designations use letter symbols described in instruction booklet. Where possible, show buildings separate from grounds with	For particular designations use letter symbols described in instruction booklet, or as shown below. Where possible, show buildings separate from grounds with	Where possible, use letter symbols shown below for particular use designations.
51.0 Governmental 52.0 Educational 53.0 Cultural 54.0 Religious 55.0 Medical 56.0 Institutional 57.0 Welfare 58.0 Places of Assembly 59.0 Indoor Recreation	51 Governmental (G) 52 Educational (E) 53 Cultural (C) 54 Religious (R) 55 Medical (M) 56 Institutional (I) 57 Welfare (W) 58 Assembly (A) 59 Indoor Recreation (R)	5.1 Governmental (G) 5.2 Educational (E) 5.3 Cultural (C) 5.4 Religious (R) 5.5 Medical (M) 5.6 Institutional (I) 5.7 Welfare (W) 5.8 Assembly (A) 5.9 Indoor Recreation (R)
6. PARKS & RECREATION		
61.0 Publicly Owned Open Space - parks, forest preserves, zoos 62.0 For Public or Private Golf Course, add 63.0 Private Open Space - camps, golf driving ranges, baseball parks, country clubs, etc. 64.0 Cemeteries	61 Public Open Space 62 For Public or Private Golf Course, add 63 Private Open Space	6.1 Public Open Space 6.2 For Public or Private Golf Course, add 6.3 Private Open Space
7. UTILITIES		
71.0 Sewage Disposal Works 72.0 Refuse Dumps, Incinerators 73.1 Electric Stations & Sub-stations 73.2 Gas Works & Related 73.3 Water Supply Facilities 73.4 Communications Facilities - telephone bldgs., radio towers, etc.	71 Sewage Disposal Works 72 Refuse Dumps, Incinerators 73 Electric, Gas, Water & Communications	7.1 Sewage Works, Refuse Dumps, Incinerators 7.3 Other Utilities

TABLE F.11.1. (Continued)

COLUMN A (COMMUNITY SCALE)	COLUMN B (COUNTY SCALE)	COLUMN C (METROPOLITAN SCALE)
Detail Surveys of Buildings and/or Land Use: 1" = 200' & Larger Scales	Predominant Land Use Surveys and Analyses Scale: 1" = 200' - 1" = 900'	Scale: 1" = 1000' & Smaller Scales
8. AGRICULTURAL		
81.0 General Farming & Small Holdings, Cropland	81 General Farming, Small Holdings, Cropland	8.1 General Farming, Small Holdings, Crops
		8.2 Fruit, Truck Farms, Nurseries, Greenhouses, Small Animals & Birds
83.0 Orchards & Fruitland	83 Orchards & Fruitland	
84.1 Vegetable Truck Farms, Nurseries, Greenhouses	84 Truck Farms, Nurseries, Greenhouses, Small Animals & Birds	
84.2 Small Animal & Bird Raising		
85.0 Permanent Pasture, Dairyland, Stock Animal Raising, Uncultivated Agricultural Land	85 Pastureland, Dairyland, Stock Animals, Uncultivated Agricultural Land	8.5 Pasture, Dairyland, Stock Animals, Uncultivated Agricultural Land
9. MISCELLANEOUS USES		
91.0 Vacant Property	91 Vacant Property	9.1 Vacant Land
92.0 Woods	92 Woods	9.2 Woods
93.0 Undeveloped or Unusable Land - sandy areas, cliffsides, exposed bedrock, quarries, etc.	93 Undeveloped or Unusable Land - sandy areas, cliffsides, exposed bedrock, abandoned quarries, etc.	9.3 Undeveloped or Unusable Land
94.0 Marshlands	94 Marshlands	
95.0 Land Covered by Water	95 Land Covered by Water	9.5 Land Covered by Water

F.12: DETROIT METROPOLITAN AREA LAND USE CLASSIFICATION

The Land Use Classification Manual, published by Detroit Metropolitan Area Regional Planning Commission (1962), represented the work of a Land Classification Advisory Committee of the Metropolitan Area. The principal objective of the Committee was to develop a land use classification system which would indicate all of the land uses in a region and assist in the detailed analysis of land uses in a small area. The classification selected had to adhere to generally accepted principles which were:

1. It must be broad enough to permit classification of every land use;

2. The categories must be clearly defined and mutually exclusive;

3. The categories must be susceptible to analysis or breakdown; and

4. The code must be easy to use and it must be easy to process the information resulting from its use.

A classification had to be developed which would include a category for every type of land use in the Detroit area. However, closely related uses could be grouped and less important uses could be "lumped in a miscellaneous category under a general category: for instance, 'Residential not elsewhere classified' under 'Residential'". And land uses in other areas had to be included if comparisons among cities and regions were to be effected. The classification system or code also had to be flexible in order that it show the degree of detail required to reflect the importance of any given land use in the planning scheme. The classification system was to be amenable to simplified field and mapping procedures and to machine processing and updating of data.

No existing land use classification satisfied the requirements for the "standard" system of classification sought by the Committee. The Standard Industrial Classification (SIC) (U.S. Bureau of the Budget, 1957) came closest to meeting the criteria. However, the SIC code which is employed to classify establishments by type of economic activity, was considered to be incapable of conversion to a land use code.

> "In the first place, the SIC system uses a combination of letters and numbers for the code... But a code in which only numbers are used... is easier to use with mechanical data processing devices, which are extremely helpful in processing the data in land use studies.
>
> "Changing the SIC letters to numbers and conforming parts of the numerical code to land use classifications were not practicable for several reasons. The SIC code is not adaptable as a land use code in that its ten divisions are not the same as the ten 'major' categories; that the Committee considered most useful for land use classification purposes. For instance, "Division C, Contract Construction', or 'Division G, Finance, Insurance, and Real Estate', do not of themselves constitute useful major categories for land use classification, even though they are of sufficient importance in economic activities to be major categories.
>
> "The SIC code may be 'collapsed' from four to two digits by dropping the digits at the right, but it is not possible to go farther because the SIC does not provide distinctive categories at the one-digit level. For instance, 1 includes mining (10-14), contact

construction (15-717), and ordnance manufacturing (19)." (Detroit Metropolitan Area Regional Plan. Com., 1962).

The Committee recognized other shortcomings in the SIC code. For example, it does not provide for mixed uses because economic activities are not 'mixed' in the sense that land uses are. Neither is unused space (including unused water area, derelict land, and vacant land and structures) classified in the SIC code as it is not the basis for an economic activity. The lack of comparability between the SIC code's economic activities and land uses is further exemplified by the Committee in the case of a junkyard. As an activity this feature is part of a larger economic activity and thus in the SIC code, it is given a four-digit classification (5093). When considered as a land use, however, it is sufficiently important to be ascribed a two-digit code designation (18).

These aspects of the SIC code which have been incorporated into the Detroit system include the use, wherever possible, of the SIC subcategory titles at all levels, and the SIC order of listing subcategories. Further, SIC code numbers are indicated in the Detroit classification for comparable uses.

The land use classification prepared by the Committee is shown in part in Table F.12.1. At the first level, there are ten one-digit categories. These may be broken down to second, third, fourth, and more levels if desired. The first level categories are:

0 Residential
1 Extractive and Industrial Non-Manufacturing
2 Manufacturing
3 Manufacturing
4 Transportation, Communications, and Utilities
5 Commercial
6 Personal, Business, and Professional Services
7 Public and Quasi-Public Services
8 Recreation
9 Unused Space

A colour (Prismacolour) and screen (Zip-a-Tone) guide is provided for the purposes of displaying these categories on a map.

Mixed uses may be treated in several ways:

1. Code mixtures at a higher level of generality. This method, however, is such that mixtures of two or more basically different functions cannot be so coded. Even when this method can be introduced, information that may be needed later is lost at this stage.

2. Provide categories for mixtures. However, many different mixtures must be provided for.

3. Code the area according to its predominant use.

4. Use multiple codes for mixtures.

5. Use multiple cards for mixtures.

The Manual provides information on how to use that code and how to report the results.

TABLE F.12.1. PART OF THE DETROIT METROPOLITAN AREA LAND USE CLASSIFICATION

COMMITTEE CODE NO.		SIC CODE NO.
0	RESIDENTIAL	
01	Single-family dwellings	88
02	Two-family dwellings	88
03	Three- and four-family dwellings	88
04	Five- to eight-family dwellings	88
05	Nine- or more family dwellings	88
06	Boarding, rooming, and fraternity houses	702, 704
07	Hotels, motels, and tourist homes	7011, 7012, 7013
08	Mobile home parks	7031
09	Residential not elsewhere classified	88
1	EXTRACTIVE AND INDUSTRIAL MANUFACTURING	
10	Agriculture	01, 02
101	Field crop farms	011
1013	Cash grain farms	0113
1019	Other field crop farms	0119
102	Fruit, tree nut, and vegetable farms	012
1022	Fruit and tree nut farms	0122
1023	Vegetable farms	0123
103	Livestock farms	013
1032	Dairy farms	0132
1033	Poultry farms	0133
1039	Livestock farms not elsewhere classified	0139
104	General farms	014
1042	General farms primarily crop	0142
1043	General farms primarily livestock	0143
1044	General crop and livestock farms	0144
108	Noncommercial farms	021
1082	Part-time farms	0212
1083	Residential farms	0213
1084	Institutional farms	0214
11	Agricultural services and hunting and trapping	07
111	Agricultural services, except animal husbandry and horticultural sciences	071
1112	Cotton ginning and compressing	0712
1113	Grist mills, including custom flour mills	0713
1114	Corn shelling, hay baling, and threshing services	0714
1115	Contract sorting, grading, and packing of fruits and vegetables for the grower	0715
1119	Agricultural services not elsewhere classified	0719
112	Animal husbandry services	072
1122	Offices of veterinarians and animal hospitals	0722
1123	Poultry hatcheries	0723
1129	Animal husbandry services not elsewhere classified	0729
113	Horticultural services	073
114	Hunting and trapping, game propagation	074
12	Forestry	08
121	Timber tracts	081
122	Forest nurseries and tree seed gathering and extracting	082
1222	Forest nurseries	0822
1223	Tree seed gathering and extracting	0823

TABLE F.12.1. (Continued)

COMMITTEE CODE NO.		SIC CODE NO.
1	EXTRACTIVE AND INDUSTRIAL MANUFACTURING (Cont'd)	
124	Gathering of gums and barks	084
1242	Gathering of gums (except pine gum) and barks	0842
1243	Extraction of pine gum	0843
125	Forestry services	085
126	Gathering of forest products not elsewhere classified	086
13	Fisheries and fishery services	09
131	Fisheries	091
1312	Finfish	0912
1313	Shellfish	0913
1319	Miscellaneous marine products	0919
138	Fishery services	098
14	Mining	10, 11, 12, 13, 14
141	Dimension stone	
142	Crushed and broken stone, including riprap	
143	Chemical and fertilizer mineral	147
1432	Barite	1472
1433	Fluorspar	1473
1434	Potash, soda, and borate minerals	1474
1435	Phosphate rock	1475
1436	Rock salt	1476
1437	Sulfur	1477
1439	Chemical and fertilizer mineral not elsewhere classified	1479
144	Sand and gravel	
145	Miscellaneous nonmetallic minerals	
1451	Clay, ceramic, and refractory minerals	145
1454	Nonmetallic minerals services	148
1457	Miscellaneous nonmetallic minerals	149
147	Crude petroleum and natural gas	13
1471	Crude petroleum and natural gas	131
1472	Natural gas liquids	132
1473	Oil and gas field services	138
148	Metals	10
1481	Iron ores	101
1482	Copper ores	102
1483	Lead and zinc ores	103
1484	Gold and silver ores	104
1485	Bauxite and other aluminum ores	105
1486	Ferroalloy ores, except vanadium	106
1488	Metal mining services	108
1489	Miscellaneous metal ores	109
149	Coal mining	
1491	Anthracite coal	11
1492	Bituminous coal	12
15	Metals and minerals wholesalers	5091, 5092
151	Coal and other minerals, except petroleum	5091
152	Petroleum bulk stations and terminals	5092
16	Construction - general contractors	15, 16
161	Highway and street construction	
162	Heavy construction, except highway and street construction	
163	General building contractors	151

TABLE F.12.1. (Continued)

COMMITTEE CODE NO.		SIC CODE NO.
1	EXTRACTIVE AND INDUSTRIAL MANUFACTURING (cont'd)	
17	Special trade construction	17
171	Plumbing, heating, and air conditioning	
172	Painting, paper hanging, and decorating	
173	Electrical work	
174	Masonry, stonework, tile setting, and plastering and lathing	
	1741 Masonry, stone setting, and other stonework	
	1742 Plastering and lathing	
	1473 Terrazzo, tile, marble, and mosaic setting	
175	Carpentering and wood floorwork	
	1751 Carpentering	
	1752 Floor laying and other floorwork not elsewhere classified	
176	Roofing and sheet metalwork	
177	Concrete work	
178	Water well drilling	
179	Miscellaneous special trade contractors	
	1791 Structural steel erection	
	1792 Ornamental metal work	
	1793 Glass and glazing work	
	1794 Excavating and foundation work	
	1795 Wrecking and demolition work	
	1796 Installation or erection of building equipment not elsewhere classified	
	1799 Special trade contractors not elsewhere classified	
18	Junkyards - scrap and waste wholesaling	5093
19	Other industrial non-manufacturing not elsewhere classified	

F.13: ECOLOGICALLY BASED REMOTE SENSING CLASSIFICATION SYSTEM FOR THE KANANASKIS, ALBERTA REMOTE SENSING TEST CORRIDOR

Allan Legge, Charles Poulton, and others (1974) reported on a study, the central objective of which was to test and adopt an ecological classification system developed by Poulton (1972). The system was applied to the subalpine forest region of the Kananaskis, Alberta Remote Sensing Test Corridor. The authors explained the benefits attributable to this type of classification system as follows:

> "A legend for resource analysis is a shorthand by which one describes, explains and annotates a landscape, its resources and uses. When one begins to use synoptic imagery - aircraft and space acquired - it is quickly realized that a synoptic or uniform manner of classifying landscapes is needed. The luxury of changing classification systems with changing jurisdictional agencies across the synoptic image scene is no longer desirable. A classification oriented to single-use interests is equally objectionable and unnecessarily costly.
>
> "The need is for a legend of resource and land classification that is fervently ecological, yet which provides for an integration of data about the landscape, its resources and its modifying uses. In the modern context it must also have a consistent logic and be a computer- compatible information system. Because we now have increased capability to exploit space and aircraft imagery in combination with ground based data acquisition, legends must be hierarchical in this design so that they match the resolution and information content possible at any specified scale and intensity of examination or at each level of a multistage sampling design." (Legge et al., 1974).

In the classification (Table F.13.1) system, all categories are hierarchical from general to specific. They are based on criteria that are unique to each primary class. Thus, for example, the criteria for vegetation classes 300 and 400 are physiognomic and structural (i.e., similarity of appearance and layered vertical structure of the plant communities through the third level. The fourth level is floristically determined; and more-refined levels are based on plant sociological criteria which define specific plant communities, ecosystems, or habitat types. A similar logic appropriate to each of the other primary classes is used in their respective hierarchical sets.

The classification when tested in the Kananaskis area of Alberta demonstrated that the primary, secondary, and tertiary levels developed by Poulton (1972) "were sufficient to provide the integrated basis for developing a more detailed regional legend classification for the ... Test Corridor within the 100, 200, 300, 600, and 700 classes (other classes are not dealt with)" (Legge et al., 1974).

The multistage sampling scheme demonstrated that a given area of the earth's surface can easily be

1. viewed in a regional perspective (Stage I, ERTS imagery);

2. viewed in perspective within a more localized framework (Stage II, 1:94,000 colour-infrared photography);

3. analyzed in detail sufficient for many inventry and management needs (Stage III, 1:47,000 colour-infrared photography); and

TABLE F.13.1. ECOLOGICALLY BASED REMOTE SENSING CLASSIFICATION (after Poulton)

CLASSES	EARTH SURFACE AND LAND USE FEATURES
PRIMARY CLASSES	
100	BARREN LAND
200	WATER RESOURCES
300	NATURAL VEGETATION
400	CULTURAL VEGETATION
500	AGRICULTURAL PRODUCTION
600	URBAN, INDUSTRIAL, TRANSPORTATION
700	EXTRACTIVE INDUSTRY, NATURAL DISASTERS
800	RECREATION AND OPEN SPACE-RELATED
900	OBSCURED LAND
PRIMARY CLASSES	
SECONDARY CLASSES	
TERTIARY CLASSES	
QUATERNARY CLASSES	
100	BARREN LAND
110	Playas, dry, or intermittent lake basins
120	Aeolian barrens (other than beaches and beach sand)
121	Dunes
122	Sandplains
123	Blowouts
130	Rocklands
131	Bedrock outcrops (intrusive and erosion-bared strata)
132	Extrusive igneous (lava flows, pumice, cinder and ash)
133	Gravels, stones, cobbles and boulders (usually transported)
134	Scarps, talus and/or colluvium (system of outcropping strata)
135	Patterned rockland (nets or stripes)
140	Shorelines, beaches, tide flats, and river banks
150	Badlands (barren silts and clays, related metamorphic rocks and erosional wastes)
160	Slicks (saline, alkali, soil structural, non-playa barrens)
170	Mass movement
190	Undifferentiated complexes of barren lands
200	WATER RESOURCES
210	Ponds, lakes, and reservoirs
211	Natural lakes and ponds
212	Man-made reservoirs and ponds
220	Water courses
221	Natural water courses
222	Man-made water courses
230	Seeps, springs and wells
231	Seeps and springs
232	Wells
240	Lagoons and bayous
250	Estuaries
260	Bays and coves
270	Oceans, seas, and gulfs
280	Snow and Ice
281	Seasonal snow cover
282	Permanent snow fields and glaciers
290	Undifferentiated water resources

TABLE F.13.1. (Continued)

CLASSES	EARTH SURFACE AND LAND USE FEATURES

PRIMARY CLASSES

SECONDARY CLASSES

TERTIARY CLASSES

QUATERNARY CLASSES

300 NATURAL VEGETATION
- 310 Herbaceous types
  - 311 Lichen, cryptogam, and related communities
  - 312 Prominently annuals
  - 313 Forb types
  - 314 Grassland, steppe, and prairie
  - 315 Meadows
  - 316 Marshes
  - 317 Bogs and muskegs
  - 319 Undifferentiated complexes of herbaceous types
- 320 Shrub/scrub types
  - 321 Microphyllous, non-thorny scrub
  - 322 Microphyllous thorn scrub
  - 323 Succulent and cactus scrub
  - 324 Halophytic shrub
  - 325 Shrub steppe
  - 326 Sclerophyllous shrub
  - 327 Macrophyllous shrub
    - 327.1 Willow (Salix) Predominent Vegetation
    - 327.2 Birch (Betula) Predominent Vegetation
    - 327.3 Alder (Alnus) Predominent Vegetation
    - 327.4 Mixed Shrub (Prunus/Symphoricarpos/Crataegus)
    - 327.9 Undifferentiated shrub types
  - 328 Microphyllous dwarf shrub
    - 328.1 Spruce-Fir (Picea-Abies) Krummholz types
    - 328.2 Mountain Health Types (Vaccinium/Cassiope/Phyllodoce)
    - 328.3 Mountain Avens types (Dryas)
    - 328.4 Juniper (Juniperus) - Bearberry (Arctostaphylos) types
    - 328.9 Undifferentiated
  - 329 Undifferentiated complexes of shrub/scrub types
- 330 Savanna-like types
  - 331 Tall shrub/scrub over herb layer
  - 332 Borad-leaved tree over herb layer
  - 333 Confierous tree over herb layer
  - 334 Mixed tree over herb layer
  - 335 Broad-leaved tree over low shrub layer
  - 336 Coniferous tree over low shrub layer
  - 337 Mixed tree over low shrub layer
  - 339 Undifferentiated complexes of savanna-like types
- 340 Forest and woodland types
  - 341 Conifer forests
    - 341.1 Pine (Pinus) Prominent Vegetation
    - 341.2 Douglas Fir (Pseudotsuga) Prominent
    - 341.3 Pine/Spruce (Pinus/Picea)
    - 341.4 Spruce (Picea) Prominent
    - 341.5 Spruce/Fir (Picea/Abies)
    - 341.6 Fir/Larch (Abies/Larix)
    - 341.9 Undifferentiated
  - 342 Broadleaf forests
    - 342.1 Poplar (Populus) Prominent Vegetation

TABLE F.13.1. (Continued)

CLASSES	EARTH SURFACE AND LAND USE FEATURES

PRIMARY CLASSES

SECONDARY CLASSES

TERTIARY CLASSES

QUATERNARY CLASSES

300 NATURAL VEGETATION (cont'd)
- 342.2 Birch (Betula) Prominent Vegetation
- 343 Conifer-broadleaf mixed forests and woodlands
  - 343.1 Pine/Poplar (Pinus/Populus)
  - 343.2 Spruce/Poplar (Picea/Populus)
  - 343.3 Douglas Fir/Poplar (Pseudotsuga/Populus)
- 340 Forest and woodland types (cont'd)
- 344 Broadleaf-conifer mixed forests and woodlands
  - 344.1 Poplar/Pine (Populus/Pinus)
  - 344.2 Poplar/Spruce (Populus/Picea)
  - 344.2 Poplar/Douglas Fir (Populus/Pseudotsuga)
- 349 Undifferentiated complexes of forest and woodland types
- 390 Undifferentiated natural vegetation

400 CULTURAL VEGETATION
- 410 Cultural herbaceous types
  - 411-419 Tertiary levels duplicate those of Natural Vegetation (300)
- 420 Cultural shrub/scrub types
  - 421-429 Tertiary levels duplicate those of Natural Vegetation (300)
- 430 Cultural savanna-like types
  - 431-437, 439 Tertiary levels duplicate those of Natural Vegetation
- 440 Cultural forest and woodland types
  - 441-443, 449 Tertiary levels duplicate those of Natural Vegetation
- 490 Undifferentiated cultural vegetation types

500 AGRICULTURAL PRODUCTION
- 510 Field crops
- 520 Vegetable and truck crops
- 530 Tree, shrub, and vine crops
- 540 Pasture
- 550 Horticultural specialties
- 560 Non-producing fallow, transitional, or idle land
- 570 Agricultural production facilities
- 580 Aquaculture
- 590 Undifferentiated agricultural production

600 URBAN, INDUSTRIAL, AND TRANSPORTATION
- 610 Residential
- 620 Commercial and Services
- 630 Institutional
- 640 Industrial
- 650 Transportation, communications, and utilities
- 651 Man and material transport
  - 651.1 Rail
  - 651.2 Motor vehicle
  - 651.3 Water
  - 651.4 Air
  - 651.5 Trails, foot and animal
  - 651.9 Undifferentiated
- 652 Utilities distribution

TABLE F.13.1. (Continued)

CLASSES	EARTH SURFACE AND LAND USE FEATURES

PRIMARY CLASSES

SECONDARY CLASSES

TERTIARY CLASSES

QUATERNARY CLASSES

653 Power production
654 Communication
655 Sewer and solid waste
659 Undifferentiated
670 Vacant plots and lots
690 Undifferentiated urban

700 EXTRACTIVE INDUSTRY AND NATURAL DISASTERS
710 Non-renewable resource extraction
711 Sand and Gravel
712 Rock quarries
713 Petroleum extraction - gas and oil fields
714 Oil shale and sand extraction
715 Coal/peat
716 Non-metallic, chemical, fertilizer, etc.
717 Metallic
719 Undifferentiated
720 Renewable resource extraction
721 Forest harvest
721.1 Clearcut forest
721.2 Selective forest cut
722 Fisheries
729 Undifferentiated
730 Natural disasters
731 Earth
732 Air
733 Fire
734 Water
735 Disease
739 Undifferentiated

800 RECREATION AND OPEN SPACE RELATED
810 Natural greenways, open space and buffer zones
820 Preservation areas and natural museums
830 Improved and developed open space
840 Historical and archeological sites
850 Scenic views
860 Rock hounding, paleontological sites
870 Recreation facilities
880 Designated destructive use areas
890 Undifferentiated

900 OBSCURED LAND
910 Clouds and fog
920 Smoke and haze
930 Dust and sand storms
940 Smog
990 Undifferentiated obscured land

4. mapped in intensive detail for highly site-specific information needs (Stage IV, 1:29,000 colour-infrared photography).

The authors pointed out that once the basic vegetational-soils-landforms classification system is established, data gathered at any one level of detail may be applied to ecologically analogous areas using the classification system as a common denominator. Finally, they observe that the holistic approach of this system will provide a picture of land use and human activity in an ecological perspective in a current time frame.

F.14: ECOLOGICAL GRADING AND CLASSIFICATION OF LAND-OCCUPATION AND LAND-USE MOSAICS

In 1977, Pierre Dansereau published a paper on land use classification wherein he proposed a "new system more uniformly based on ecological criteria and less narrowly geared to the yields that are useful to man". He stated that:

> "I consistently hyphenate land-use. This is meant to emphasize the conventional, technical meaning of this term. In fact, I find it more appropriate to refer to land-occupation (also hyphenated) instead of land-use inasmucn as some of the areas of not 'used' by man at all and were never actually occupied by him or have long reverted to the 'natural' or indigenous agents (mineral, plant, animal) that originally tapped is resources. Thus land-occupation is a more fundamental term." (Dansereau and Paré, 1977).

The new system which Dansereau titled Ecological Land-Occupation (ELO), accordingly represents a change in emphasis from use to occupation. Land-occupation patterns may be best understood when they are graded according to the dynamics of their component ecosystems. A model of the ecosystem is introduced as background to the definition and placement of ecological land-occupation types.

Dansereau briefly considered a number of well-tested classification systems such as the World Land Use Survey (A.1), the first and second Land Utilization Surveys of Britain (A.2), the Canada Land Inventory (B.1), and a derivation of the latter (B.9). He observed that:

> "The logic of these classifications... rests upon the dichotomy of used vs. unused land. It tends to reflect what man has done to the land. There is, however, no linear sequence from either the most intensively used or the most productive to the least used (or distributed) or least productive in the scheme as a whole or in its subdivisions. The colours that are proposed do not reflect... any particular relationship (except within a given subdivision). The main concern is obviously legibility and practical application.
>
> "These preoccupations are appropriately utilitarian. The first British land-use scheme (which is the prototype of all of them) is obviously slanted to agriculture, as it may well have been in war-time Britain. There is yet another reason for this in the fact that agricultural land (however used or neglected) not only occupies larger areas than corresponding industrial or urban affectations, but also consists of larger cells. As for wild, 'natural', or 'semi-natural' areas, the logic in recognition of categories does not lie so much in their contrasting inherent features as in their usefulness." (Dansereau and Paré, 1977).

It is essential, argued Dansereau, "to separate description from potential..." while interpretation of aerial photographs to determine the land-mosaic of things-as-they-are is an objective, necessary exercise it is in no way self-explanatory.

"The present (and possibly quite ephemeral) occupation of land can only be explained by overlaying it with equally precise data, some of which pertain to natural forces and others to man's impact". Thus climate, physiography, soil, vegetation, and animal life must be understood in considerable detail, as must be their manipulation, exploitation, and transformation by man, both in a retrospective and prospective sense. Given these background requirements for classification, there remains the task of determining how many major and minor categories there are, how they relate to each other, and how they should be defined. Ultimately it is the retrieval of information gathered from the correlation of background data and actual occupation, as well as relative yield, which will permit the design of prospective categories of classes of potential.

Dansereau's definition of ecosystem is as follows:

> "An ecosystem is a limited space where the cycling of resources through one or more trophic levels is effected by more or less fixed agents utilizing mutually compatible processes, simultaneously and successively, which engender products that are usable or short or long term." (Dansereau and Paré, 1977).

Dansereau's model of the ecosystem encompasses biocycling processes from the uptake of minerals by plants, the elaboration of plant tissues through photo synthesis and other processes (primary production); the consumption of plants by phytophagous animals that build up tissues and organs (secondary production) that will be consumed by carnivorous animals (food- chains); and the partial return by bioreduction to soil, water, and atmosphere. The energy relays are extended through two more levels, investment and control. The former refers to storage of resources not in immediate use (e.g., starch, fat in bodies of animals and plants); and to the perpetuation of artifacts of continuous or periodic usefulness (e.g., fences, houses, levees, reservoirs). Control refers to generally persistent "power of leverage" on the cycling processes (e.g., a beaver in a pond, cyclic fire in a paranna).

Dansereau divided the ELO into four large units or panels, an arrangement determined by the historical escalation of man's power over environment. The panels are as follows.

> "PANEL A. Wild lands essentially obey the laws of nature; their component ecosystems being under the sway of long-established heredity/environment contests, display indigenous processes of stabilization and change. Although they need not be unused by man, and may even be indirectly managed, they are not under his immediate and visible influence. Primary and secondary productivity dominate and there is virtually no actual consumption by man. Trophic activities at levels I to IV predominate.
>
> "PANEL B. Rural lands are much transformed but sparsely occupied by man. The indigenous and other spontaneous flora and fauna are usually eliminated (or else subjected to systematic culling) and replaced by chosen useful species and varieties. The dominant processes are agrigenous, geared to agricultural yield, which involves a simplification of agents intended to bolster to the extreme primary and/or secondary productivity of chosen plants and animals. Strict management cultivation, breeding, harvesting, consumption, storage, and export are the main categories. Trophic levels I, II, and III are heavily weighted, but investment (V) has priority.
>
> "PANEL C. Industrial lands are marked by very heavy investment, sophisticated information, very dense occupation, and intense use. The component ecosystems are dependent upon import of raw materials, efficient processing and massive export. Fabrigenous processes geared to

technology are in command, allowing virtually no spontaneous activity at levels II, III, IV, whereas large investments (V) prevail subject to fluctuating (usually external) controls (VI). The productivity in industrial space is strictly tertiary.

"PANEL D. Urban land is quite densely built-up and harbours a numerous and concentrated human population. Urbigenous processes are the inescapable solutions to metabolic problems of dense congregations of men; favouring inner diversification, they are meant to satisfy all human needs (physiological, psycho-social, economic, cultural) and therefore command a great variety of investments (V) that must submit to various means of control (VI). Shelter, storage, exchange, communication are the dominant processes leading to massive occupation by artifacts. Consumption (and indeed, survival) in urban spaces is dependent upon the tapping of other ecosystems having a strong phytogrophic (primary) and zootrophic (secondary) productivity and also upon the tertiary yields of industry." (Dansereau and Paré, 1977).

These panels are incorporated into the new scheme for classifying the land-occupations for the world (Table F.14.1). The system's major divisions (or Management Regimes) are tied to the escalation of man's power over environment (from gathering to exobiological escape), and recognize as categories of the first order or level, the four panels described above. Dansereau continued:

"The second order reflects the kind of exploitation (extraction, processing, etc.), and this also is amenable to linear progression of a sort, or at least to assemblage in homogeneous blocks. It is primarily based on process.

"The third order is the type of occupation (quarry, orchard, etc.), which is characterized either by a resource or an agent.

"A denominator is given to these digits, based upon the trophic level that bears the heaviest energy burden... and is numbered accordingly: I to VI.

"Emerging categories may thus be assembled in a formula that contains the essential information. In the upper line, A, B, C, or D (regime) refer to one of the major panels; the blocks, showing the kind of exploitation, are numbered in arabic figures, whereas the the type of occupation is represented by a capital letter. The dominant trophic level(s) is given as a denominator. The whole formula for a land-occupation type reads as follows:

$$\frac{C\ 1\ J}{I}$$

which is spelled out:

C for industrial land (regime) (panel),
1 for predominance of extraction of mineral raw materials (kind of exploitation) (block),
J for quarry (type of occupation),
I for predominance of minerotrophy....

"I have made an attempt to allow for all the possible subdivisions known to me as of potential world-wide occurrence in the three orders, although extensive discussions and tests have given me warning that yet other groupings can well arise at the third- or fourth-order levels. It also will be argued that some lower-case units should be raised to the third order.

"There clearly emerge many fourth and fifth orders, and in a number of instances I have given examples thereof, ... There would seem to be an almost unlimited number of them if one scans the whole planet for application of this scheme. I will hardly attempt this now (although I am confident that it can eventually be achieved), but I feel bound to develop my application to the fourth and fifth subdivisions in a good number of instances so as to get down to the concrete level where such a comprehensive classification stands some chance of practical recognition". (Dansereau and Paré, 1977).

In the same paper in which the ELO classification was presented, Gilles Paré addressed the methods and problems associated with mapping the new classification.

TABLE F.14.1. ECOLOGICAL LAND-OCCUPATION (ELO) CLASSIFICATION

BLOCKS	TROPHIC LEVELS	TYPES	METHOD
		PANEL A. WILD	
6 Animal aggregation	III, IV	A Mammal herd	T-P
		B Bird colony	P-T
		C Coral reef	P-T
		D Shell bank	P-T
5 Predominance of woody plants on upland		A Forest	P
		B Parkland	P
		C Savanna	P
		D Scrub	P
		E Tundra	P
4 Predominance of herbaceous plants on upland	II	A Prairie	P
		B Meadow	P
		C Steppe	P
		D Desert (see A 1)	P
		E Crust	P

Note:
Panels (A. Wild, B. Rural, C. Industrial, D. Urban) show the regime of land-occupation in the order of increasing management by man.
Blocks (1, 2, 3, ...) indicate the progression (from bottom to top) of energy input, and the shifts from one group of processes to another.
Types (A, B, C, D, E, ... or Aa, Ab, Ac ...) are the exact kinds of occupation of a wide geographical range.
Trophic Levels: I. Minerotrophy, II, Phytotrophy, III. Zootrophy (herbivory), IV. Zootrophy (carnivory), V. Investment, VI. Control.
Method: P: airphoto reading sufficient (1:20,000 or less)
T: field-work necessary (visual inventory, analysis, survey)
P-T: airphoto reading possible. Field-work desirable for verification
T-P: field-work preferable. Airphoto reading possible.

Example
The formula for a unit area reads, for example:

$\frac{A\ 3\ D}{II}$ = bog

$\frac{B\ 2\ Ea}{V,\ II}$ = maple sugarbush

$\frac{C\ 2\ Eg}{V,\ I}$ = gravel road

$\frac{D\ 3\ B}{V}$ = playground

MOBILE ELEMENTS

In A, B, C, D:

(a)	Trees in a row	P
(b)	Hedge, hedgerow	P
(c)	Fence	T
(d)	Pylons	P-T
(g)	Pasture	P
(j)	Garden/kitchen garden	P
(l)	Lawn	P
(n)	Snow	P
(q)	Grove	P
(s)	Path, driveway	P-T

In B, C, D:

(f)	Channel	P-T
(t)	Parking lot	P
(u)	Construction	P-T
(w)	Irrigation	T-P
(x)	Abandoned	T-P

In A only:

(p)	Unmanaged park	T
(r)	Fully-protected reserve	T

TABLE F.14.1. (Continued)

BLOCKS	TROPHIC LEVELS	TYPES	METHOD
		PANEL A. WILD (cont'd)	
3 Wetlands		A Swamp forest	P-T
		B Marsh	P
		C Saltmarsh	T-P
		D Bog	P
2 Water	I, II, III, IV	A Sea	P
		B Estuary	P
		C Lagoon	P
		D Salt lake	T
		E Flowing water (river, streams cataract)	P
		F Still water (lake, pond)	P
		G Ice	P
		H Snow	T
1 Raw minerals	I	A Volcanic elements	P
		B Rock (outcrop, cliff, flat)	P
		C Gravel	P
		D Sand (beach, dune, spit)	P
		E Silt	T-P
		F Clay	P
		G Salt flat	T-P
		PANEL B. RURAL	
5 Construction and Maintenance	V	A Yards and outbuildings	P
		B Recreation space	T-P
		C Greenhouses	P
	V, II, I	D Clearing	P
4 Breeding	V, III, IV	A Wild animals (see D 2 A)	T
		B Fur-bearing animals	T
		C Draft and riding animals	T
		D Butchery animals	T
		E Dairy animals	T
		F Wool-bearing animals	T
		G Pets	T
		H Poultry	T-P
		I Pisciculture	T-P
		J Apiculture	T-P
		K Silkworm orchard	T
		L Earthworms	T
3 Pasture	V, III	A Improved pasture (enclosed, permanent in rotation)	P-T
		B Unimproved pasture (itinerant, extensive)	P-T
2 Woody-plant exploitation		A Lumbering (selective cut, burn, clear-cut)	P-T
		B Nursery	P
		C Vineyard	P-T
		D Orchard	P
		E Tapping (sugar, rubber, resin, bark, cork)	T
		F Plantation	P
		G Fruiting shrub	P-T
1 Cropping of herbaceous plants	V, II	A Sod	P-T
		B Fruiting plants	P-T
		C Foliage plants	P-T

TABLE F.14.1. (Continued)

BLOCKS	TROPHIC LEVELS	TYPES	METHOD
		PANEL B. RURAL (cont'd)	
		D Roots, tubers, bulbs	T
		E Fiber plants	T-P
		F Medicinal plants	T-P
		G Aromatic plants	T-P
		H Oil plants	T-P
		I Cereals	P-T
		J Fodder and silage	P-T
		K Mushrooms	T
		L Flowers	P
	V, I	M Fallow	T-P
		PANEL D. URBAN	
7 Administration, public service		A Governmental	T
		B Public	T
		C Private	T
6 Institution	VI, V	A Financial	T
		B Military	T-P
		C Religious	T
		D Educational	T-P
		E Medical	T-P
		F Cultural	T
5 Commerce		A Hostelry	T
		B Restaurant	T
		C Stores (shopping centre, shops)	T
		D Market	T
		E Warehouse	T-P
4 Residence	V	A Single-family (mansion, cottage, bungalow, rowhouse, semi-detached, shack)	T-P
		B Multifamily (duplex, triplex-multiplex, apartment house, highrise)	T-P
3 Open Spaces		A Stadium (open, closed)	P
		B Playground	P
		C Marina	P-T
		D Racetrack	P
	V, III, IV, II	A Zoo (see B 4 A)	T-P
		B Botanical garden	P-T
2 Green Spaces	V, II	C Golf links	P
		D Park	P-T
		E Cemetery	P
1 Paved or unplanted spaces	V, I	A Square, plaza	T-P
		B Dump	P
		C Junkyard	P
		D Vacant lot	P
	V, II, III, IV	A Cleaning	T
		B Storage	P-T
		C Washing	T-P

TABLE F.14.1. (Continued)

BLOCKS	TROPHIC LEVELS	TYPES	METHOD
		PANEL C. INDUSTRIAL	
5 Services	V, I	D Garage	T-P
		E Repairs	T
		F Filtration plant	T-P
4 Manufacturing		G Reservoir	P-T
		A Wool	T
		B Leather, skins	T
		C Oil, fat	T
	V, III, IV	D Meat	T
		E Fish and invertebrates	T-P
		F Dairy products (casein, cheese, butter, cream, milk)	T
		G Wood (pulp-and-paper, sawmill, furniture)	P-T
	V, II	H Fruit and vegetables	T
		I Fibre (textiles)	T
		J Spirits (distillery, brewery)	T
		K Jewellery	T
		L Rock and sand	T
		M Clay (brick, ceramics)	T
		N Metal and mineral	T
		O Petroleum	P-T
		P Coal	T-P
		Q Mineral water	T
3 Energy		A Solar plant	T
		B Nuclear plant	T-P
		C Thermal plant	P-T
		D Hydroelectric plant	P-T
		E Hydraulic mill	P-T
		F Windmill	P-T
2 Transport and Communications		A Telecommunication	P-T
		B Airport	P
		C Railroad and station	P
		D Port and shipyard	P
		E Road and highway	P
		F Transmission line	P
	V, I	G Ducts (pipeline, aqueduct, pumping station)	P-T
		H Bridge	
		I Lighthouse	P
		J Clearing and filling operations	P
1 Extraction	V, III, IV	A Bones	T
		B Manure (guano, manure)	T
		C Sod (see B 1 A)	P-T
		D Peat	P
	V, II	E Litter (straw, compost)	T
		F Muck, humus	T
		H Mine	P-T
		I Salina	T
		J Quarry	P
		K Gravel	P
	V, I	L Sand	P
		M Clay and silt	P-T
		N Petrol	P-T
		O Gas	P-T

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